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INTELLIGENCE, SOCIOECONOMIC STATUS AND SHORT-TERM MEMORY

BY

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Intelligence, Socio-economic Status, and Short-term Memory" submitted by Donald [illegible] in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

The current study examines the relationship between intelligence, socioeconomic status (SES) and short-term memory. Three types of short-term memory tasks (auditory, visual, and a cross-modal coding) were given to MA matched groups of children of two levels of IQ (low average and retarded) and two level of socio-economic status.

The study was designed to test the Jensen hypothesis that on rote-associational types of tasks, the performance of the low IQ (60 - 80), low SES (culturally deprived) children is better than that of their middle and upper class counterparts of similar IQ. Furthermore, the role of acoustic and semantic interference in short-term memory was examined in relationship to retarded-normal differences.

The findings were that the Jensen hypothesis was confirmed in the visual short-term memory, and the semantic, auditory short-term memory tasks. Significance was not reached in the other experimental tests, but in each case the results were in the predicted direction. The performance of low average subjects was superior to that of the retarded subjects even though MA matching was used. Thirdly, interference effects were more severe for the retarded than for the low normal subjects.

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The main implication drawn from the results is that Jensen's theory [illegible] the types of cognitive

ability has generalization beyond experimental situations which differ from those on which he based his theory. Furthermore, the theory is also predictive when samples that are not as disparate as Jensen's are tested.

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INTRODUCTION AND DEFINITION OF TERMS

During the last few years, there has been an increased awareness of the educational needs of those children who do not conform to a stereotypic image of an average, normal child. Programs in special education have varied from providing additional enrichment and opportunity to the intellectually gifted to providing remediation and extra teaching to the educationally handicapped, be they emotionally disturbed, neurologically impaired, mentally retarded, or culturally deprived.

Research on cultural deprivation has been extended to include many dimensions of behavior. Experiments on specific environmental influences, such as parent-child interactions, is one line of endeavor. Another area of research, particularly in educational psychology, concerns the developmental study of intelligence. Controversy has surrounded intelligence, its definition and measurement. Intertwined with research on intelligence and cultural deprivation has been the nature-nurture issue or as it is also known, the heredity-environment question. It seems as if most of the controversy stems from disagreement as to the proportions that heredity or environment contribute to the unfurling of a given trait. We do know, however, that there are effects from the environment which do

operate within the limits imposed by genetic endowment.

One of the aspects of intellectual capacity, which seems to be multifaceted, concerns the processing of information. Individuals who come from culturally disadvantaged environments tend to process information in a way that does not lead to academic success or to average scores on standard tests of intelligence. Yet, in later life, many of these individuals are able to financially support themselves and function in society. The claim has been made that current intelligence tests do not sample certain types of cognitive behavior, relevant to education, on which lower and upper class groups of children differ. Short-term memory is one type of cognitive ability which is not adequately assessed by current measures of intelligence.

In the current investigation, no attempt will be made to resolve, once and for all, the nature-nurture issue as it relates to the development of intelligence. However, there will be an attempt to delineate some of the common ground on which retardates from high and low socioeconomic status are similar. Furthermore, the performance of these two groups will be compared with non-retarded individuals also of high and low socioeconomic status on a small subset of intellectual behavior involving information processing. More specifically, in this investigation an attempt is made to show on which intellectual

tasks and under what conditions the children defined as retarded, culturally deprived or both perform on some rote-associational cognitive abilities on a par with their non-retarded or non-culturally deprived counterparts. Thus several cognitive tasks, all within a relatively restricted range of cognitive operations, are examined in relationship to varied levels of intelligence and socioeconomic status.

Definition of Terms Used in the Study

The following list of terms is provided to acquaint the reader with the operational terminology that is used in this investigation.

Intelligence: is defined as the measured intelligence test score obtained from the child's school cumulative record form. The low IQ children were all obtained from opportunity classes for the educable mentally retarded (IQ's from 50 - 80). Normal IQ subjects were children from regular grade two or three classes with IQs less than 100 but not lower than 80.

Socioeconomic status (SES): This variable was defined on the basis of Blishen's (1961) occupational rating scale. The upper cut-off point for the low SES groups was a Blishen rating of less than 42.6. The lower limit of the middle to high SES group was a Blishen rating of 47.2.

Mental age (MA): is defined purely on the basis of

the child's IQ times his chronological divided by 100.

Short-term memory (STM): is defined as retention as measured by the methods presented in Chapter II. Basically this definition of STM is based on performance rather than process. Performance on a typical "short-term memory" task (Peterson & Peterson, 1959; Baddeley, 1966; and Gumenik, 1969) is implied rather than the specific portion of the memory system in the typical short-term and long-term memory distinction (Adams, 1967; Howe, 1970; and, Atkinson and Shiffrin, 1968). Generally, STM refers to retention of information over short temporal spans of less than one minute.

Long-term memory (LTM): is defined as the retention of information over temporal spans of longer than one minute. Usually the time spans are measured in minutes, hours, days, and years as opposed to seconds in STM.

Acoustic similarity: is defined as the homophonic similarity between two or more words.

Semantic similarity: is defined as the similarity of meaning of two or more words.

Retardate or retarded: for the purposes of this investigation refers to the individual who has a measured IQ between 50 and 80 and who was in a special class for the educable mentally retarded.

Culturally deprived individuals: refers to the subgroup of the retardates who have a low SES rating.

Normal, low normal, average or low average: refers to those individuals who were in a regular grade two or three class who had IQ's between 81 and 99 inclusive.

CHAPTER II

THEORETICAL CONSIDERATIONS AND RELATED LITERATURE

Introduction

The purpose of this chapter is to provide a theoretical foundation for the research of this investigation. Presented in this chapter are discussions of short-term memory, of the theoretical formulations of A. R. Jensen, of cross modal coding, and discussion of how short-term memory tasks relate to Jensen's theory.

Jensen's Model for Understanding Intelligence

Jensen has written extensively on intellectual and cognitive factors. The articles range from reports of research on specific cognitive abilities to a large comprehensive article on intelligence which was published in the Harvard Educational Review (1969). Only those portions of Jensen's formulations will be included that are directly relevant to the current investigation.

One area of mental retardation that has come to the forefront is that of intellectual inadequacy related to so-called cultural deprivation. The measured, average intelligence of the poor does not compare favorably with that of the rich. The typical finding is that as one moves down the socioeconomic scale, intelligence also decreases. Tyler (1965) quotes studies in which the correlation between

occupation and IQ are between 0.30 and 0.70. However, Jensen (1969) points out that among educable mentally retarded (EMR's) individuals, economically poor children are much superior to rich EMR children on cognitive measures which are somewhat different from the typical Stanford-Binet or WISC type items with the exception of digit span.

Jensen (1969) has provoked much discussion and critical thinking on the nature-nurture issue. In his article in the winter issue of the Harvard Educational Review, 1969, he re-examines much of the existent literature that relates to the heredity-environment controversy. He reaches the conclusion that the genetic component in the development of intelligence is larger than was popularly accepted. He tenders a heritability estimate of 0.80 for intelligence. In other words, Jensen places much less stress on the plasticity of intelligence than do many psychologists and educators.

There have been many replies to his article that have ranged widely from critically written scientifically based discussion, to emotionally based letters to the editor of popular magazines that brand Jensen as a racist or fascist. In the current discourse, some of the criticism of his position on intelligence and socioeconomic status is included.

The Model

Jensen (1969) has presented a model of human abilities in which the effects of socioeconomic status (SES) are taken into consideration.[a] He started with the observation that low (SES), low IQ (60 - 80) children appear to be brighter in some ways than middle class children of similar IQ. This has been often noticed by special class teachers. He bases his findings on the results of direct learning tasks such as paired associates, serial recall, and digit span. Figure 1 is illustrative of the relationship.

On the basis of the results of the direct learning tasks as well as the results of differential factor analyses on high and low SES groups, Jensen has proposed a two dimensional model for understanding social-class differences of cognitive ability. The first dimension is the familiar dimension of cultural loading. The psychometric tests used by psychologists or psychometrists prior to a special class placement vary in degree of cultural bias. Tests like the Raven's Progressive Matrices are generally regarded as being less culturally biased than other tests such as achievement tests. However, the

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[a]For a comprehensive statement of Jensen's total position see Harvard Educational Review, Winter 1969, and Ellis 1970, International Review of Research in Mental Retardation, Vol. 4.

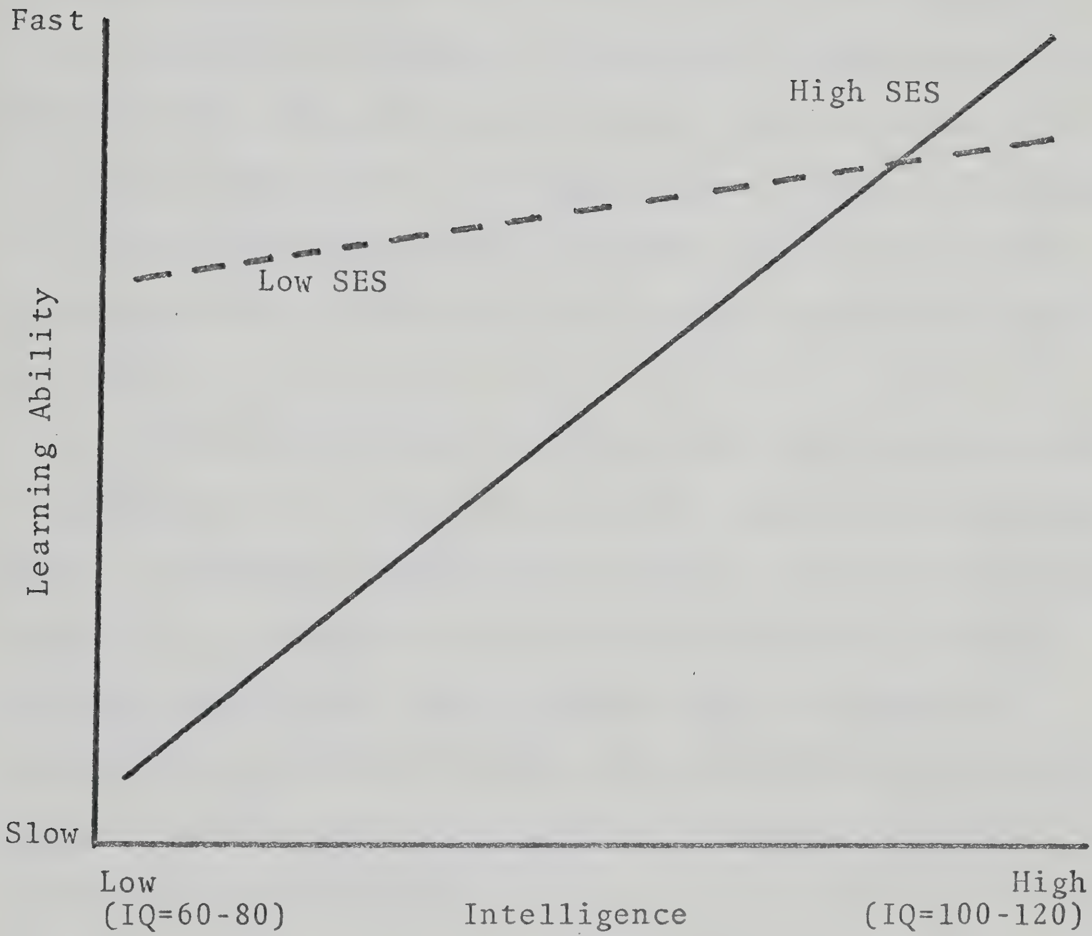

Fig. 1. Summary Graph of a Number of Studies, Showing the Relationship Between Learning Ability (Free Recall, Serial and Paired-Associate Learning, and Digit Span) and IQ as a Function of Socioeconomic Status (SES)

following two findings have led Jensen to postulate a second dimension: (i) that Negro children perform more poorly on the Raven's Progressive Matrices which requires complex abstract reasoning ability than on the Stanford-Binet which has a variety of conceptual tasks (Higgins and Sivers, 1958; Sperrazzo and Wilkins, 1958 and 1959), and (ii) that Negro youths performed better, relative to Whites, on IQ test items which were judged to be cultural rather than non-cultural (McGurk, 1951; Dreger and Miller, 1960, pp. 366-7).

The second dimension that Jensen has added concerns the complexity of the learning task. Tasks and tests vary along a continuum ranging from simple, associative learning (level I), to conceptual learning and abstract problem solving (level II). Thus a digit span test would be predominantly a level I task, while a concept formation-problem solving test such as Raven's Matrices would be mainly a level II task.

Furthermore, the assumption is made that the dimension of degree of complexity is hierarchical in nature. The simpler processes are thought of as necessary but not sufficient for the development and use of the higher level functions. A low degree of ability on level I would lead to low level II functioning. It is possible that through the distribution of individual differences, a person may have good level I ability but poor level II ability.

Thus, these persons would have subnormal performance on standardized intelligence tests, yet would appear to be brighter than indicated by the tested IQ on some dimensions of intelligent behavior.

Jensen's two dimensional model is presented graphically in Figure 2.

A further postulate of Jensen's theory is that there is a differential distribution of level I and level II abilities in the low and high SES groups. Basically, level I abilities appear to be equally distributed in the two socioeconomic classes. Thus, Jensen hypothesizes that there is an underlying genetic distribution of level I ability which is independent of social class. However, level II abilities are distributed in quite a different manner. The middle and upper classes have less individuals who have poorly developed level II abilities than the lower classes. That is, the mean of level II abilities is higher in middle and upper SES levels than the lower SES groups (see Figure 3).

Since level II abilities are generally the type of intellectual functioning that is necessary for relatively good performance on standardized intelligence tests, it becomes important then to look at the possible reasons of the apparent impaired performance of the children who are labelled as disadvantaged and placed in special classes. Jensen addresses himself to this problem. He argues that

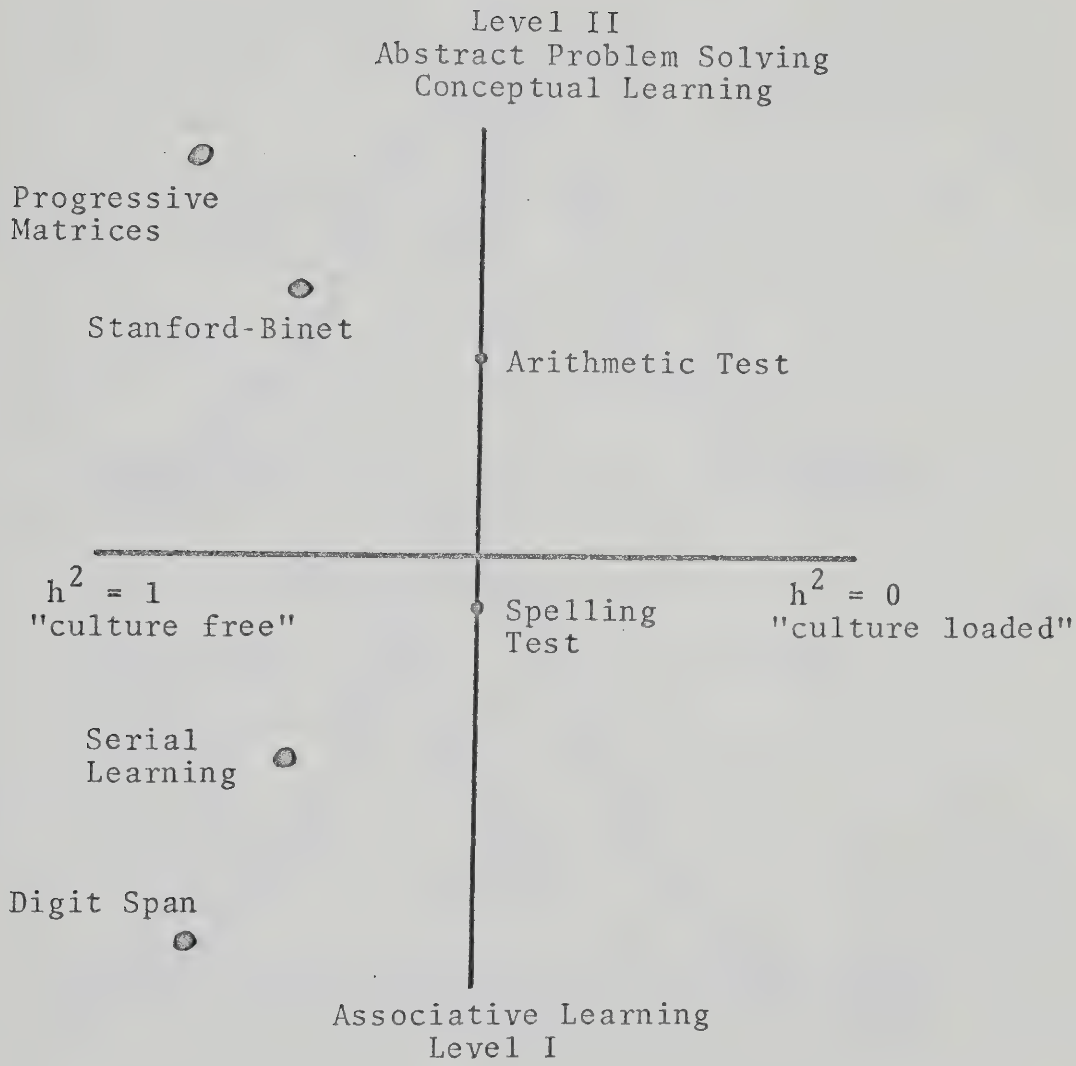

Fig. 2. The Two-Dimensional Space Required for Comprehending Social-Class Differences in Performance on Tests of Intelligence and Learning Ability. The Locations of the Various Tests in This Space are Speculative

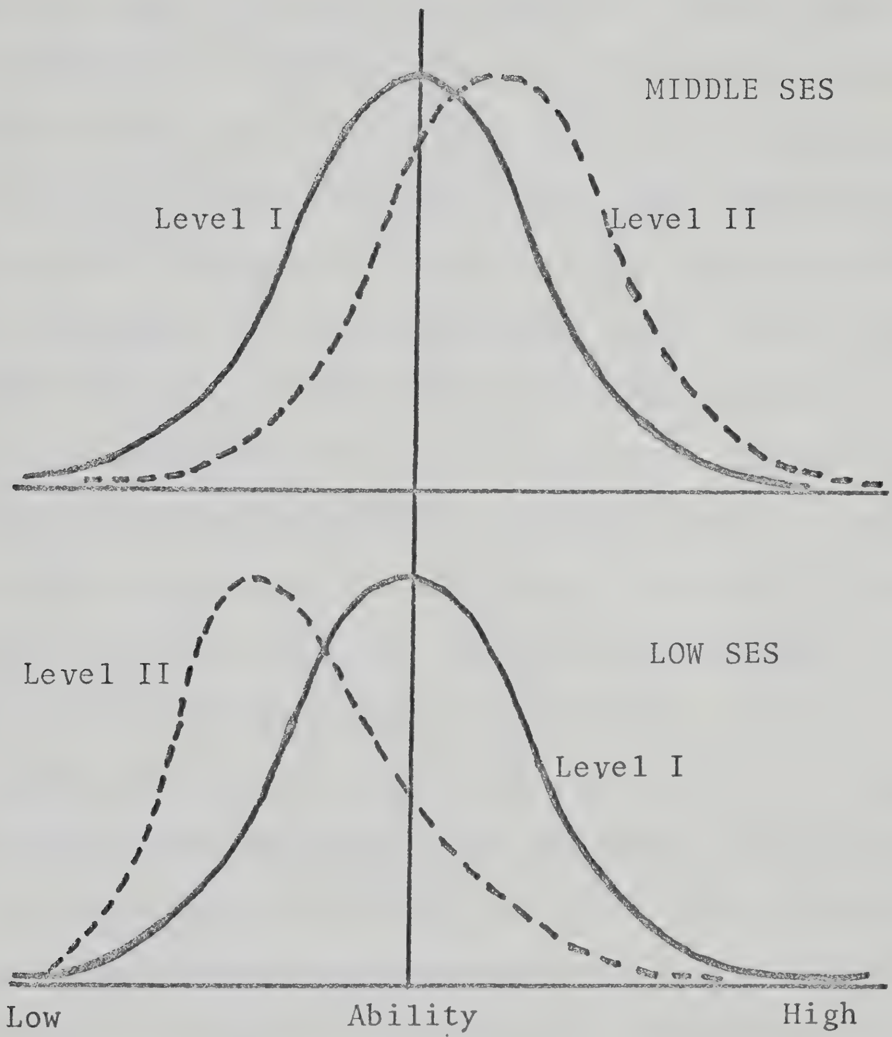

Fig. 3. Hypothetical Distributions of Level I (Solid Line) and Level II (Dashed Line) Abilities in Middle-Class (Upper Curve) and Culturally Disadvantaged (Lower Curve) Populations

the environmental life experiences of the disadvantaged child are such that the development of level II abilities is not fostered. However, when low and middle SES children are matched for IQ, the low SES, low IQ children do better at the level I tasks than do the high SES, low IQ children. The average IQ children of both low and high SES perform about the same level on associative tasks. Since IQ tests are mainly level II type tasks, and since there is a functional dependence of level II on level I, the average IQ individuals have adequately developed level II and therefore adequate level I abilities. However, in the low IQ group, both the high and low SES children have inadequately developed level II abilities. But there is a difference between low and high SES children. The high SES children tend to have poorly developed level I ability and thus poor level II ability as well. On the other hand, many low SES children have adequate level I ability even though level II ability is inadequate. Therefore on associative tasks, the low IQ, low SES children outperform their low IQ, high SES counterparts.

This apparently paradoxical performance related to SES could also be explained in the following manner. Suppose that an intelligence test samples a mixture of level I and level II abilities and that on the given intelligence test the ratio is 40% level I and 60% level II for average IQ subjects. Then an IQ of 100 would represent

a contribution of 60 IQ points from those items which measure level II and about 40 IQ points for those items which tap level I abilities. This relationship is for average intelligence. However, when we come to retarded population, the mixture could be quite different. On the assumption that for both of the SES levels the IQ is 65, a hypothetical contribution of level I and II is postulated. For the high SES group it may be something like this:

30 points level I
35 points level II
65 total IQ points

The contribution in the low SES may be quite different and look like this:

40 points level I
25 points level II
65 total IQ points

Thus when groups are matched for IQ and MA the following results would be expected on level I type tasks.

(1) The low SES subjects of IQ = 65 would perform about equal to or slightly inferior to the average IQ subjects.

(2) The low SES subjects of IQ = 65 would be superior in level I performance to the high SES subjects of IQ = 65 because of the difference of level I ability which was shown on the IQ test. Jensen hypothesizes that this would

arise from a differential genetic distribution underlying cognitive ability in the two SES classes.

The general principle underlying this postulate is the tendency for the more intelligent children in a family to marry more intelligent mates and move up the socioeconomic scale. Similarly, the less intelligent family members tend to marry less intelligent spouses and move down the socioeconomic scale relative to the SES level of their parents. The term assortive mating is applied to this phenomena. It is through the principle of assortive mating that many low SES individuals have adequate level I (which is distributed independent of social class) but inadequate level II ability.

Jensen argues that success in school is dependent on level II ability and that the economically poor child is not represented fairly by the standard IQ tests which tend to depend fairly strongly on abstract-conceptual skills. Furthermore such a child's performance in school would be inadequate even though in some ways he shows skills that are superior to those of his upper or middle class counterpart. This would be expected if we were able to determine that his level I skills were in fact equal to those of a child of normal ability. Therefore children who are defined as culturally deprived, and who are academically retarded because they are taught in the traditional ways,

could be educated so that level II deficiencies could be minimized. Possibly, level I abilities could be used to overcome level II inadequacies. It is Jensen's (1969b) hope that tailoring the educational program to fit a specific child's cognitive abilities, through individualized instruction, would allow educators to become more successful with the culturally deprived. Thus, the results and conclusions that Jensen tenders have relevance for both assessment procedures and teaching strategies.

Jensen summarizes his position as follows:

> Low-SES children with low measured IQs (60 to 80) are generally superior to their middle-class counterparts in IQ on tests of associative learning ability: free recall, serial learning, paired-associate learning, and digit span. Low-SES children of average IQ or above, on the other hand, do not differ from their middle class counterparts on these associative learning tasks. This interaction among IQ, associative learning ability and socio-economic status has been found in groups of children sampled from Caucasian, Mexican-American and Negro populations. (. . .)
>
> These findings are important because they help to localize the nature of intellectual deficit of many children called culturally disadvantaged, they bring a sharper focus to the nature-nurture problem as it relates to social class and racial differences in mental ability; they show that environmental deprivation does not have an equal effect on all mental abilities; and they emphasize the need for standard tests to assess a broader spectrum of mental abilities than is sampled by current tests of intelligence (Jensen, 1969c, p. 33).

Criticisms of Jensen's Model

Several authors have responded to Jensen's position on the genetic aspects of the development of intelligence.

However since the current study was not designed to examine this issue, the criticisms of that part of Jensen's postulates will be omitted. The main criticisms are restricted to the controversy which surrounds his conception of intelligence and level I and II abilities.

Bereiter (1969) does not consider Jensen's finding of superior level I ability in low SES individuals to be very startling. He says, "I do not see Dr. Jensen's proposal, that educators look for ways to make school learning less dependent on intelligence, as a very radical one (p. 313)." He goes on to make the point that education should have the aim of bringing intellectual tools within the reach of as many individuals as possible. However, he does not see this as reducing any of the present differences between groups. Rather, he suggests that the development of better and more varied teaching methods would serve to widen the gap between those who have adequate amounts of problem-solving ability and those who do not. In summary, then, Bereiter's main criticism is not so much of Jensen's model but rather of his optimism and hope that the utilization of level I abilities may serve to reduce the differences between the retarded and normal portions of our population.

Deutsch (1969) raises quite different issues than Bereiter. He questions the advisability of dichotomizing intelligence into two sets of abilities and teaching by rote

or associational methods. Deutsch is doubtful if a person taught in such a way would be able to shift to a conceptual mode of instruction. Since rewards in a technical society are associated with conceptual work, he wonders if it is really valid to hope to reduce any retarded-normal differences by an instructional strategy based on rote-associational methods.

The second criticism that Deutsch raises is in the concept of intelligence that Jensen employs. His basic point is that the Spearman g is the theory of intelligence that is assumed. Levels I and II are based on g according to Deutsch. Other current acceptable models of intelligence have not been taken into consideration by Jensen.

Another comment that Deutsch makes is in the consideration of levels I and II as learning styles rather than as specific abilities. His objection is that if style of cognitive approach is implied, more than two would be necessary to explain differences in learning ability.

Other criticisms of Jensen's model can be raised. It is apparent from Jensen's writing that his model is basically two dimensional. The familiar test dimension of culture fair to culturally biased is not in question. Rather one can question the validity of the second dimension. Rote-associational or simple cognitive processing seems to be at one end of the continuum and abstract-conceptual problem solving ability is at the other extreme. But Jensen

himself, in his factor analyses, makes the point that there are clusters of abilities at each end of the continuum. Therefore an alternative explanation is possible if Jensen's second dimension is divided into two orthogonal dimensions. There are really three dimensions being discussed: (i) the culture fair-culture loaded, (ii) simple rote-associational dimension from high to low, and (iii) abstract-conceptual dimension from high to low. This alternative interpretation is congruent with Jensen's theory. He hypothesizes that there are two types of cognitive ability, levels I and II, for which there are two separate genetic distributions: one for abstract conceptual abilities and one for rote-associational abilities. Thus dividing his second dimension into two separate, independent dimensions would serve to emphasize the hypothesized underlying independence of the two genetic distributions.

The development of abstract-conceptual abilities, however, may be affected by number of years of schooling. In a cross cultural setting in South Africa, where children enter school at various chronological ages, Schmidt (1966) has found that performance on the Raven's Progressive Matrices was influenced, not by CA *per se*, but by number of years of schooling. Number of years of education needs to be considered in future research and comprehensive theories on the development of reasoning abilities.

Memory

Jensen uses paired associate learning, serial learning and digit span tasks as measures of rote-associational (level I) abilities. These tasks are also used in research on short-term memory. Jensen (1968) has published results of his research on short-term memory as it relates to his theory. He finds that digit span tasks are some of the best measures of level I ability. His tasks are quite different from the typical WISC, WAIS, or Stanford-Binet type of digit span task, but are along the same lines as most of the typical short-term memory experiments and similar to the short-term memory tasks used in this investigation.

Generally speaking, research in the area of memory is one of two kinds. The first type of research is concerned with performance on a memory test of some description. The purpose of this research is to use memory to make inferences about other variables of interest such as personality (Eysenck, 1967) or intelligence (Jensen, 1969). The second type of memory research concerns the memory processes *per se*. Studies which relate to the storage and retrieval processes in memory are numerous. In other words, the general mechanisms of memory are of prime interest (see Atkinson and Shiffrin, 1968; Posner, 1969; Peterson and Peterson, 1959; Murdock, 1965; Howe, 1967 and 1970; Wickelgren, 1968).

The current investigation concerns, mainly, the first type of memory research mentioned above. Basically, the tests of short-term memory of this investigation are used as one type of cognitive ability. However, an attempt will be made in Chapter V to link the findings of this study to the current rubric of existing research on memory processes. The following discussion of short-term memory is included to familiarize the reader with the relevant short-term memory issues.

Model for Human Memory

Before the now classic study of Peterson and Peterson (1959) there had been little active research on short-term memory. In 1958, Broadbent presented a general model for information processing but he had limited research on which to base his theory. Since the late 1950's research on memory has been increasing both in number and in sophistication.

Within the last decade or so, several models for the memory system have been proposed (see e.g. Howe, 1970). However, most of the models are modifications and improvements on Broadbent's (1958) model based on research subsequent to 1958. The recent model of Atkinson and Shiffrin (1968) is selected for inclusion in this chpater, because it incorporates the essential features of most of the other models for memory. In this sense, it is

representative of most current models.

The memory system is divided into three basic subsystems. While the functions of each of the systems are quite distinct, the evidence that the systems are in different parts of the cortex is far from conclusive. The report of Milner (1959) lends support to at least two ways of storing and/or retrieving information. The evidence is taken from case histories of surgical intervention in the relief of severe epilepsy. A specific individual had a bilateral, medial, temporal-lobe resection. Subsequent to the operation, he was unable to recall events in the immediate past unless he actively rehearsed the desired information. For events prior to surgery, his memory was clear. Thus, it appears that the long-term storage facility was still operative and the short-term memory component could be used but the connection between the two had been severed during surgery. No new information was able to enter the long-term storage unit. Therefore, at least two storage mechanisms are operative in information processing.

The memory system is composed of three distinct functioning units: the sensory register (SR), the short-term store (STS) and the long-term store (LTS). STS and LTS are not to be equated directly with long- and short-term memory. The terms long- and short-term memory are used to refer to the duration of time accompanying a given experimental task. No assurance is given that retrieval is

from STS or LTS. This idea will be more fully developed later in this chapter.

The sensory register (SR) is the subsystem of memory which stimuli first activate. Evidence for the existence of SR separate from STS and LTS is cited in Howe (1970), Sperling (1960, 1963), Averback & Coriell (1961) and Mackworth (1963). According to Sperling (1960), there is a peripheral visual storage for retention over exceedingly brief periods of time. Atkinson and Shiffrin (1968) and Howe (1970) suggest the temporal boundary for the visual sensory register is less than one second and probably on the order of 500 milliseconds. A similar system for auditory material has not yet been fully established.

The second subsystem of memory involves the short-term store (STS) or as Waugh and Norman (1965) call it, primary memory. There are several essential functions that are specific to the STS. First, all information that reaches LTS first passes through STS, where it may or may not be actively rehearsed to retain it in STS. As long as active rehearsal takes place, information can be maintained in STS. A schematic diagram of Atkinson and Shiffrin's model is presented in Figure 4. However, there seems to be a limit as to the amount of information that can be actively rehearsed in the STS. Atkinson and Shiffrin have proposed the idea that this store contains a rehearsal buffer of fixed capacity. New items displace old items in active

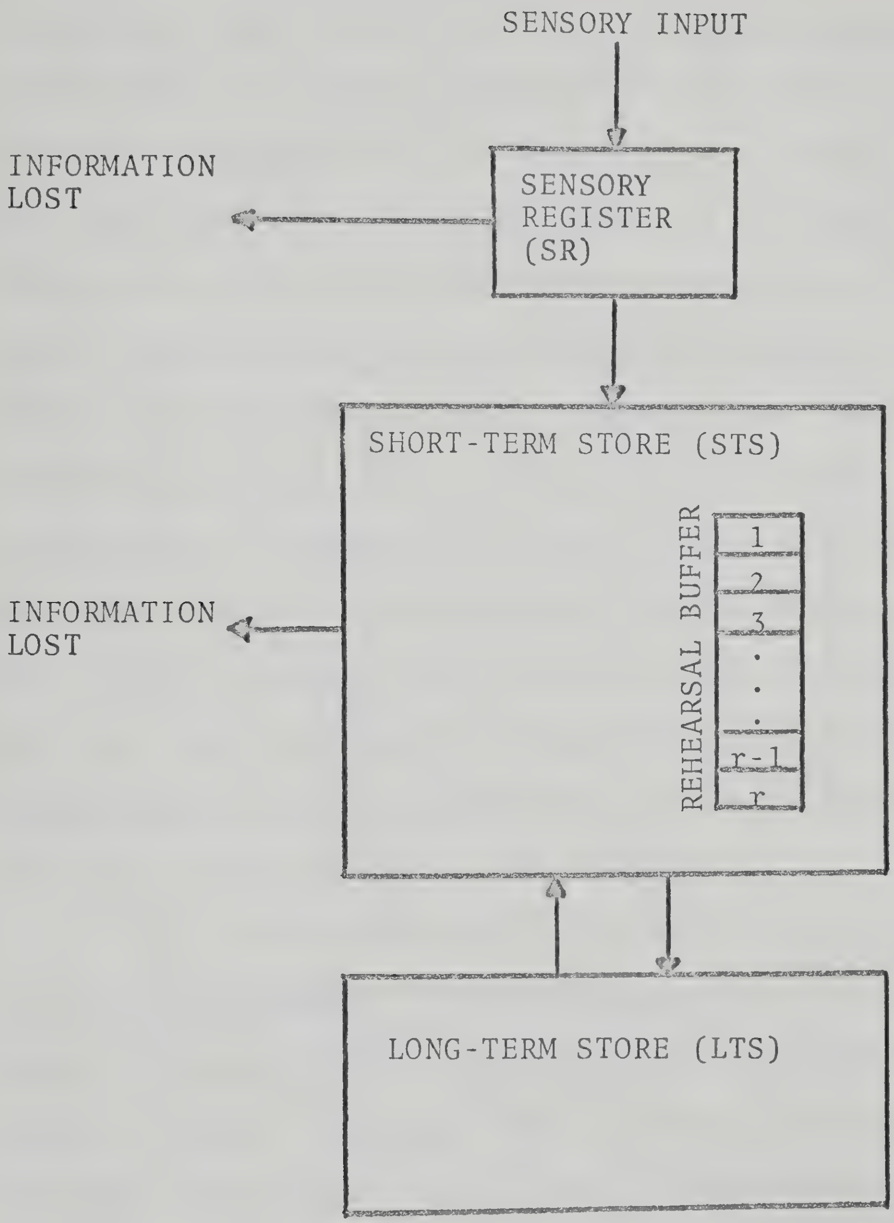

Fig. 4. Structure of the Memory System (Atkinson and Shiffrin, 1968)

rehearsal. The size of the buffer depends on the nature of the material that is being rehearsed and on the learning strategy that is being employed by the subject. The idea that part of the STS works as an "Echo box" or rehearsal buffer until more complex coding has time to take place, has been proposed by Waugh and Norman (1965) and Atkinson and Shiffrin (1968) respectively. Howe (1970) concurs with this idea as he presents his model which incorporates a rehearsal circuit as part of STM. He also includes a scanning device which inspects the contents of the STS to determine what should be retained and rehearsed. Thus not only storage is incorporated into memory but also some control processes which are linked to other cognitive processes like selection and attention.

The long-term store (LTS) or secondary memory (SM) in Waugh and Norman's (1965) framework is the part of the memory system in which information is retained over long temporal spans. Storage tends to be on the basis of meaning and associations rather than on specific phonetic articulatory codes (Howe, 1970). Retention of information over a long temporal span is basically a storage function. However, retrieving the information from long-term storage is dependent on the quality of input and retrieval mechanisms. The familiar "tip of the tongue" phenomena have led authors such as Norman (1969) to conclude that locating information in the LTS poses the greatest problem

in retrieval. Differences in recall and recognition measures of retention can be accounted for, according to Norman. He suggests that recognition tasks frequently provide cues as to where to look in the LTS for the information. Free recall on the other hand does not provide such cues and thus the information may not be retrieved as readily.

However, since the tasks of this investigation are of short temporal duration, and since it is a typical short-term memory task, no further discussion of LTM is included. More complete descriptions of LTM and its function are available elsewhere (Adams, 1967; Atkinson and Wickens, 1969; Norman, 1968; Norman, 1969; and Howe, 1970).

Acoustic Nature of STM

Many authors and researchers accept the findings that primary memory is acoustically based (Adams, 1967; Conrad, 1967; Wickelgren, 1965; Gumenik, 1969). That is to say, STM appears to use an auditory or speech motor code (Wickelgren, 1965). The research basis for this postulate is contained in studies in which the effects of acoustic confusion in STM are examined. Evidence supporting an auditory trace hypothesis of STM rather than a motor feedback hypothesis of STM is presented by Gumenik (1969).

Generally speaking, most of the studies of acoustic confusibility follow from the work of Conrad (1964). He

found that when letters were presented against a background of white noise, similar sounding letters tended to be confused more frequently than did letters which did not sound similar. Similarly, Wickelgren (1965) found that the probability of making an intrusion error, that is an error involving acoustic confusion, was in direct ratio to the number of similar sounding letters in the alphabet.

In a series of experiments, Baddeley (1964, 1966) and Baddeley and Dale (1966) showed the relationship of acoustic and semantic similarity to STM and LTM. Basically, the findings were that acoustic similarity was an interference variable in STM but not for LTM and that semantic similarity, that is similar meaning words in a paired-associate task, was an interference variable for LTM but seemed to have little effect on STM. Dale (1967) failed to find semantic interference effects for STM. Many researchers have also found acoustic interference effects in STM (Conrad, 1964; Levy and Murdock, 1968; Posner, 1966; and, Reicher, Ligon and Conrad, 1969; Gumenik, 1969). In a recent publication, Baddeley and Warrington (1970) comment that "despite the strong association between acoustic coding and STM there clearly must also be acoustic coding in LTM." Bruce and Crowley (1970) reached the same conclusion.

The experimental design of Baddeley (1966) was only slightly different from the work of Conrad (1964) and

Wickelgren (1965), in that he used similar sounding words whereas Conrad and Wickelgren used either letters or numbers. Also, Baddeley used auditory presentation with written recall while Conrad, Wickelgren, and Gumenik (1969) used visual presentation with written recall. While there were methodological variations, it is important to notice that the basic findings were similar. Craik (1970) systematically varied the input and output modalities. He concluded like Murdock (1968) that auditory presentation was superior to visual presentation. Craik further found that written recall was superior to spoken recall, but that input and output modality effects were small and limited to primary memory not secondary memory.

Summarizing then, STM seems to be based on an acoustic coding system and that LTM seems to be primarily based on semantic coding. However, as Baddeley and Warrington (1970) and Bruce and Crowley (1970) point out, some acoustic coding does take place in LTM. In the current study, interest in acoustic and semantic interference in a STM auditory task is confined to the differences between retardates and normals, and which interference affects which group most severely.

Performance and Process

A distinction is drawn in this study between performance and process. The scores obtained from the data indicate

a level of performance or proficiency of each subject on the required tasks. However, the experimental procedure was not specifically designed such that inferences regarding the underlying processes of short- and long-term memory could be easily made. The type of task that was used is one that is referred to as a typical short-term memory task in the literature, and it has been described as such here. However, no claim can be made about whether or not the storage involves only the short-term store. One cannot be sure that the storage and retrieval aspects are as neatly bifurcated in these tasks as Baddeley (1966) suggests. Thus in the tasks some information may be encoded into LTM and may become salient as retrieval mechanisms are considered. Tulving (1968) stresses that retrieval mechanisms are important for both STM and LTM.

Stimulus Presentation and Response Recording

There are several methods that are employed in the presentation of stimuli. Typically, the stimuli are presented by automatic devices so that experimental variance is minimized. Visually presented stimuli are usually shown on a screen by means of a projector which is controlled by automatic timing devices. Auditory stimuli are usually presented by means of pre-recorded tape using earphones so that extraneous noise can be excluded as much as possible.

Choice of a specific response modality is somewhat dependent on the age of subjects, type of input stimuli, and scoring intentions of the experimenter. The most common response modes are verbal repetition of input stimuli, written reproduction, or, in recognition tasks, pointing to correct response alternatives. With younger subjects response requirements must be well within their ability, otherwise coordination may in fact be the variable that is actually being measured.

These factors were considered in the choice of tasks which are described in a later section. The tasks encompassed a wide range of modalities for both input and output. The over-riding consideration of the choice was that the required activities be appropriate and familiar to the subjects, consonant with their ability.

Cross Modal Coding

One of the experimental tasks used in this investigation involves the auditory input of stimuli, and a visual recognition mode of testing the accuracy of retention. While this test is within the typical short-term memory design more complex encoding is necessary here to transfer the information from one modality to another. In this way it goes beyond the usual short-term memory type of experiment. Other research on mental retardation can be related to the current investigation if one moves outside the short-

term memory literature to the work on cross-modality transfer.

Cross modal coding is the transfer of stimuli from one modality to another without changing the meaning. Hermelin and O'Connor (1961) found that retarded (trainable level) subjects performed as well on cross modal recognition as did normals and on a tactile recognition task the retardates were superior. The material used was not easily transformed into words so that the superior verbalization of normal subjects could be brought into operation. The conclusions reached by Hermelin and O'Connor were twofold: verbal coding in the translation of stimuli from one modality to another is facilitative, but in conditions in which verbal coding is difficult, the cross modality coding loses its effectiveness.

Hermelin and O'Connor were looking at the notion that the presentation of stimuli by more than one modality was more effective than single modality presentation. Texts in teaching methods emphasize this point as it relates to the education of young children or retarded children. Birch and Belmont (1964) examined the nature of auditory-visual cross modal coding and compared the performance of retarded and normal readers. The authors found that the retarded readers were less efficient in the cross modal coding task than were the normal readers.

Hunt (1969) without citing the origin of the comment,

remarks that cross modal transfer is a good measure of basic intellectual capacity. If this is true, then the cross modal coding task in this investigation should be closely associated with the other two tests. However, since more cognitive transformations are performed in a cross modal coding task than, for example, in a straight auditory input, spoken output type of task, there should be some differences in performance between the two.

Cross modal coding can be viewed from a short-term memory framework. Basically, the task is the same as in most typical short-term memory experiments with the exception that the response modality is quite different from the input modality. The cross modal coding task in the current investigation is considered to be similar to the other short-term memory tasks.

Measures of Retention

There are several ways that an experimenter can test what the subject has retained in memory over the specified retention interval. Typically, the measures of retention are divided into two categories, recall and recognition. There has been much literature comparing and contrasting the relative merits of each (see Howe, 1970; and Adams, 1967). The difference between recall and recognition procedures is sometimes over-emphasized and the similarities minimized. Recall tends to be more rigorous than

does recognition. With recognition procedures, cue information is presented which is not available in recall methods. In terms of measures of retention, recognition probably does not influence the actual storage of the material, rather it may serve as a cue to guide the scanning of the contents of memory.

The available methods of measuring retention are given below. Free recall, ordered recall, and recognition procedures were used in the current study.

Free recall - in this type of recall the subject is requested to reproduce, in some manner, all the original stimuli with no regard to order.

Ordered recall - in this method of recall the subject is required to reproduce all of the original stimuli in the correct order. Sometimes, while serial order is requested, an experimenter will score for both serial and free recall.

Probed recall - this type recall requires the subject to reproduce a specified subset of the original stimuli. The subject may be required to reproduce the first third of the stimuli on the first trial, the last third on the second trial, and the middle third on the third trial. With probed recall, various methods, of indicating which portion of the data is required, are employed.

Recognition - generally, in recognition procedures,

the subject is required to scan stimuli in which some or all of the original stimuli are contained. The subject has to either identify the stimuli which were originally presented, or to identify the stimuli which were not originally presented, or he must decide on whether or not one or more of the stimuli followed other stimuli in the original presentation.

In both recall and recognition, the specified way in which a retention measure is obtained is limited by the experimenter's purpose, the nature of the stimuli, the age and level of sophistication of the subjects, convenience, and the experimenter's ingenuity.

CHAPTER III

PROCEDURE AND HYPOTHESES

The experimental hypotheses and design of the study are presented in this chapter. Included is a formal statement of the major and minor experimental hypotheses as they relate to subject characteristics such as IQ and socio-economic status. Descriptions of sampling, tasks, and experimental procedures are also provided.

An Overview of the Experimental Hypotheses

Since children who have the same mental age (theoretically according to the Binet concept of MA) have attained the same level of intellectual development, they should perform similarly on cognitive tasks including those of short-term memory (STM). There is some doubt that this holds good for STM. Jensen (1968) has found social class differences on rote-associational tasks. In these studies, retardates of high socioeconomic status do less well than their lower class counterparts of similar IQ. His tasks mostly involved the learning and recall of paired associates, serial lists, and digits in a digit span task. In contrast he found no such SES differences in children of average intelligence (IQ = 100-120).

Thus two major dimensions seem relevant and worthy of examination: MA and SES. These suggest two major

hypotheses:

(1) If a mental age matching indicates an equivalent level of development, there should be no difference on any of the three tasks (visual short-term memory, auditory short-term memory, and cross-modal coding) in the performance of normal and retarded subjects.

If this hypothesis is rejected it could mean at least two things. Firstly, it could mean the tasks measure some type of cognitive functioning which is independent of the measures of intelligence on which the original matching was done. Possibly then, as Baumeister (1967) suggests, another way of confirming the original diagnosis has been found. On the other hand, the differences may reflect basic mechanisms for dealing with the environment. Even though MA matching should minimize the probability of finding differences, the better performance of normal subjects would reflect more efficient mechanisms for information processing.

If on the other hand, the hypothesis is not rejected, claim could be made for the idea that the experimental tasks are along the same dimensions as the intelligence test and that the sample matching was adequate. No process differences could be tendered.

(2) The second hypothesis is taken from Jensen. Low IQ subjects of high SES should have less adequate performance than low IQ, low SES children but there should

be no differences between high and low SES subjects of average IQ. Thus a two-way interaction between IQ and SES on STM task performance is postulated. Figure 5 graphically illustrates this hypothesis.

The current investigation differs from Jensen's work in three ways: an array of input and response modalities were used with younger children than Jensen used, adjacent groups were compared rather than retarded and high average, and the range of socioeconomic status was not as diverse as Jensen described. While these differences from his experiments work against the Jensen hypothesis, if his theory has any generality, the predicted results should also be seen in these tasks.

Minor hypotheses arising from the work on interference (Baddeley) discussed in previous sections are as follows:

(1) Acoustic intra-list interference should produce poorer performance than semantic intra-list interference.

(2) Acoustic and semantic intra-list interference should produce poorer performance than the control lists which are neither acoustically nor semantically similar.

The Population

The population from which the samples were drawn included all of the members of the junior opportunity classes in the Edmonton Public School System (1968-1969), and all the

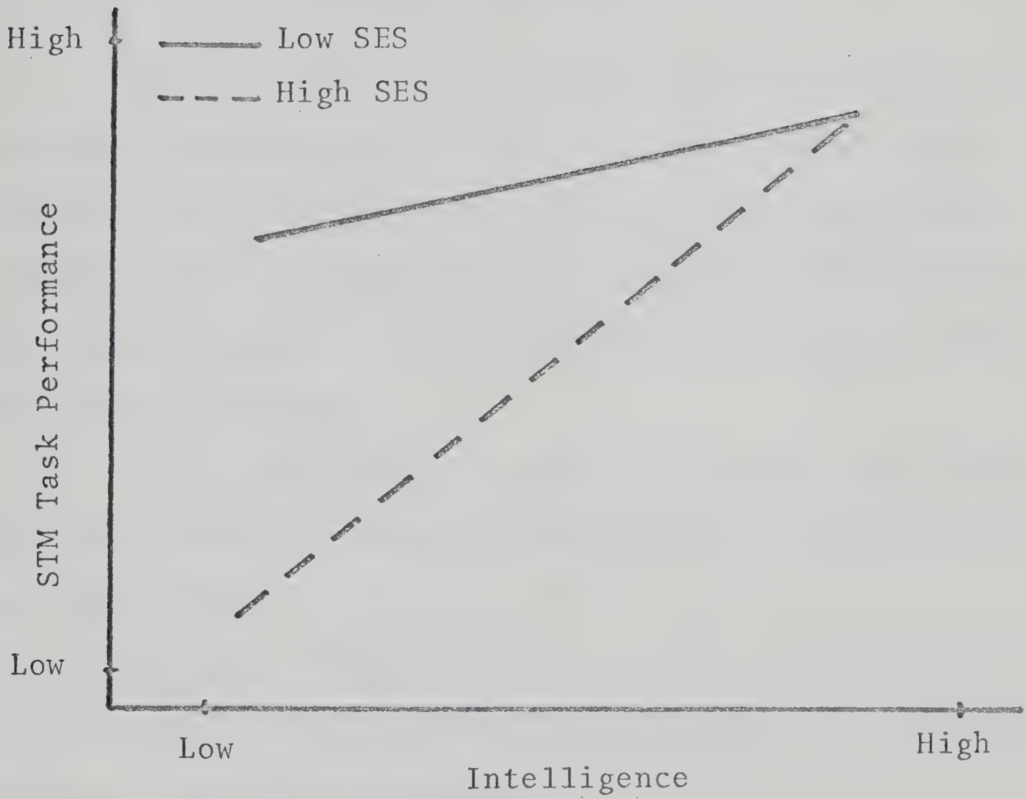

Fig. 5. Hypothesized Two-Way Interaction

children who were in grades one and two during the 1968-1969 school term who attended Edmonton Public Schools on the south side of the North Saskatchewan river.

Sampling Procedure

In total, forty-seven schools were initially visited by the author in order to draw a large enough sample so that appropriate group matching could be performed. The sampling procedure of perusing the student's cumulative record at the school was in accordance with the following guidelines:

(1) In the grade one and two classes, only those children who had a Detroit Beginner IQ of less than 100 were selected.

(2) All of the students in junior opportunity class were selected. The opportunity classes are for educable mentally retarded individuals.

(3) As much of the following information as possible was gleaned from the cumulative record: (a) sex, (b) birthdate, (c) grade in school, (d) religion, (e) IQ (Detroit or other. Note: If no Detroit Beginner IQ was available for an opportunity class student, the IQ which was most representative of all the IQ tests was recorded), (f) language spoken at home, (g) color, (h) birthorder, (i) parents' marital status, (j) child's place of residence, (k) socioeconomic (SES) data including ratings of:

(i) principal family wage earner's occupation according to Blishen (1961); (ii) source of income, type of employment, dwelling area according to Warner (1960).

Of the approximately 1,800 students selected in the above manner, 1,294 parents or guardians were successfully interviewed by telephone in order to complete and verify the above information. Interviewed were 157 opportunity class parents, and 1,137 grade one and two parents. An additional five parents were successfully contacted but they refused to answer any of the interviewer's questions.

After the survey was completed, four groups were selected from the sample using the IQ and socioeconomic data. Four groups of thirty subjects were drawn:

Group 1: low average IQ, middle to high SES,

Group 2: low average IQ, low SES,

Group 3: low IQ, average to high SES,

Group 4: low IQ, low SES.

The groups were equated in three ways. High and low IQ groups were matched for mental age and socioeconomic status. That is, groups 1 and 3 were matched for MA and SES as were groups 2 and 4. Within each IQ level, average and low, the two groups within a level were matched for IQ. A summary of the group characteristics is presented in Table 1.

TABLE 1

SUMMARY DATA FOR THE FOUR EXPERIMENTAL GROUPS

		Group 1 (Av. IQ, High SES)	Group 2 (Av. IQ, Low SES)	Group 3 (Low IQ, High SES)	Group 4 (Low IQ, Low SES)
IQ	Mean	93.93	90.20	68.63	65.53
	Std. Dev.	3.95	4.22	7.93	7.09
Mental Age (mo.)	Mean	93.73[a]	86.00	93.57[b]	85.33
	Std. Dev.	6.41	6.77	13.37	14.50
Chronological Age	Mean	99.70	95.40	136.30	130.07
	Std. Dev.	5.51	6.66	13.47	15.88
Socio-economic Status (Blishen)	Average	53.7	41.0	53.0	41.3

a - t between MA Group 1 and 2 = 4.32, $p < .001$

b - t between MA Group 3 and 4 = 2.32, $p < .05$

IQ was solely determined on the basis of the data that was available from the school record. In the regular classes, the Detroit Beginner IQ test has been used throughout the Edmonton Public School system for several years. The test is a teacher administered, teacher scored, group IQ test. For children in the opportunity class, where no Detroit was available, the IQ used for matching was the IQ score that was most representative of all the IQ tests that were given to the child. Typically, the child had received five or six tests so that this score would not be as

unreliable as taking say the highest or the lowest score.

The socioeconomic status rating used in matching was the occupational class scale by Blishen (1961). The scale was constructed from Canadian census data and is an occupational ranking according to combined standard scores for income and years of schooling. The various occupations are assigned a rank value. At times it was difficult to determine from a phone interview the exact occupation of the household wage earner especially in low status occupations. Two of the most frequently stated occupations that required careful questioning were engineer and carpenter. The stated occupation of carpenter included laborers who carry lumber, carpenter's helpers, framing carpenters on housing projects, cabinet makers, construction foremen, and project supervisors. Similarly the occupation of engineer included a spectrum of socio-economic levels. Engineer ranged from sanitary engineer -- garbage collector, through locomotive engineer to professional engineers lecturing at a university. By asking the specific duties of a given job, it was usually clear which rank was appropriate for a given individual.

A second measure of socioeconomic status was also obtained. Three of the scales devised by Warner (1949) were used. They were ratings of occupation, source of income and dwelling area. The Warner scales were mainly devised for the United States of America. However the Blishen and

Warner ratings from the survey correlated 0.80.

There are several characteristics of the sample match which are worthy of mentioning. First, this method of drawing a sample is extremely time consuming. Approximately four months of full time work was spent on visiting schools and phoning parents. Secondly, the total population was represented in that only five (0.38%) of the 1,300 (approximate) parents refused to complete the telephone interview and all schools which were asked to participate were cooperative. Thirdly, the mental ages within the high and low IQ groups were comparable as were the SES ratings within the IQ groupings. Lastly, the IQ's within each SES level were essentially equivalent.

Subject and Group Matching: Some General Considerations

In the area of mental retardation research, much controversy has centered around the appropriateness and implicit assumptions inherent in mental age (MA) and chronological age (CA) matching. Baumeister (1967) discusses the problem in some detail. In general, he says that researchers should be aware of the assumptions they are making when matched groups are used. He also asks one to consider whether or not the comparison of mentally retarded subjects with average IQ subjects is valid. Such comparisons do seem to be useful in that differences in

performance are from a baseline of average. But the usefulness of comparative studies is maximal only when, in analysis of variance designs, interaction effects are examined to see under what conditions mental retardates perform the best. Absolute differences in performance, in themselves, may not be of prime importance in comparative studies.

Other difficulties arise from matching which complicates interpretation. Floor and ceiling effects may produce significant interaction effects where none should exist, where the task is too difficult or too easy for a group of subjects. This might be overcome by comparing MA matched normals with retardates. But MA matching decreases the likelihood of finding differences in performance between retardates and normals. In the current investigation we have MA matched groups and most of these points have been taken into account. In the instructions and examples, the subject either retarded or normal, had to obtain a correct score on the practice examples before going on to the scored portions of the test.

In summary then, there are two basic ideas inherent in subject matching. CA matching tends to emphasize performance differences between the matched groups. MA matching, on the other hand, tends to emphasize differences in _process_, rather than in _level_, between normals and retardates.

Testing Conditions

In all cases, testing was completed at the school which the child attended. The space most frequently allotted for testing was the school medical room with the exception of eight of the thirty-eight schools. In these schools either a conference room, principal's office, or counsellor's office was used. In all cases, the testing was completed during a single school day. Typically, two children were tested on a given day although some days it was possible to test three children.

Two children from the retarded group had to be replaced with an additional two subjects of similar MA and SES. Both children were emotionally disturbed. One was transferred from an opportunity class to the Glenrose Hospital Emotionally Disturbed Children's Unit. The other child had just come from the Emotionally Disturbed Children's Unit and was extremely lacking in self-confidence to the point that when she was asked for any response, even her name, she responded with "I can't" and burst into tears. Therefore these two subjects were replaced.

Experimental Procedure for Auditory Short-Term Memory

The experimental procedure was fashioned after that of Baddeley (1966). He presented housewives with a series of five words which the subjects were required to recall

immediately by writing the sequence on a sheet of paper. He used two groups of subjects. One group of subjects in condition A received twenty-four sequences of words; 12 sequences were acoustically similar in sound, 12 sequences were different in sounds. The other group of subjects in condition B also received twenty-four sequences; 12 sequences which had words of similar meaning, and 12 sequences of control words with different meanings. All the sequences were drawn at random from four groups of sight words, one list of words for each condition with the constraint that a word could not appear twice in any one sequence.

A similar procedure to Baddeley's was used in the current investigation but with modification for age differences since Baddeley used adults whereas children of MA 60 to 108 months were used in this investigation. Firstly, the words chosen were within the vocabulary range of the slowest of grade one children as judged by two experienced grade one teachers. The words from which the sequences were randomly drawn are included in Appendix 1. The random order of the word sequences and list presentation sequences are presented in Appendix 2. Presented in Appendix 3 is the word lists as recorded on the tape recorder. Appendix 4 contains the instructions for the test.

The following are departures from Baddeley's methodology. Firstly, to insure that each subject knew

each of the words, he was asked to define each word before the experimental task. Secondly, the method of recall was spoken rather than written because the act of writing could possibly reduce retention since many grade two and three children write rather slowly. Thirdly, an independent judge scored the recorded responses so that experimental bias was minimized. Fourthly, the sequences consisted of four words rather than five. Lastly, the scoring procedure was different from that of Baddeley.

Two methods of scoring were used in the current investigation. Each of the lists of recorded responses were scored for free recall and serial recall. The scoring method of Baddeley (1966) was not adequate because many subjects were unable to correctly reproduce any of the word list with total accuracy. Floor effects were present. The other methods of scoring overcome the floor effects.

The free recall (FR) score was obtained for each group of four words by counting the number of words the subject was able to reproduce with position effects ignored. The serial recall (SR) score was more rigorous since the word was only counted as correct if it was also in the same serial position as the stimulus word. Total possible score for each subject was 48 for control word sequences and 48 for experimental word sequences. Table 2 shows some examples of scoring.

TABLE 2

SCORING EXAMPLES

Original Sequence	Child's Sequence	FR Score	SR Score
mat cat man can	mat cat man cat	3	3
big tall fat long	big fat tall long	4	2
cow day hot pen	car day hot blow	2	2
big fat large wide	wide fat big wide	3	2
can cat map man	can can man cap	2	1
key pen day bar	bar day pen key	4	0
bar hot key book	bar hot key book	4	4

Each individual, then, obtained four scores: an FR for control words, an FR score for experimental words either acoustic or semantic, an SR score for control words, and an SR score for experimental words.

Experimental Procedure for Visual Short-Term Memory

The experimental procedure for visual short-term memory was tailored after typical STM memory tasks in which stimuli are presented, followed by a neutral filler task to prevent rehearsal over the retention interval then recall. In the current investigation twenty grids of five numbers each were presented. Figure 6 is a sample item as seen by a subject. Following the stimulus was a filler task which the subject was required to name as many color bars

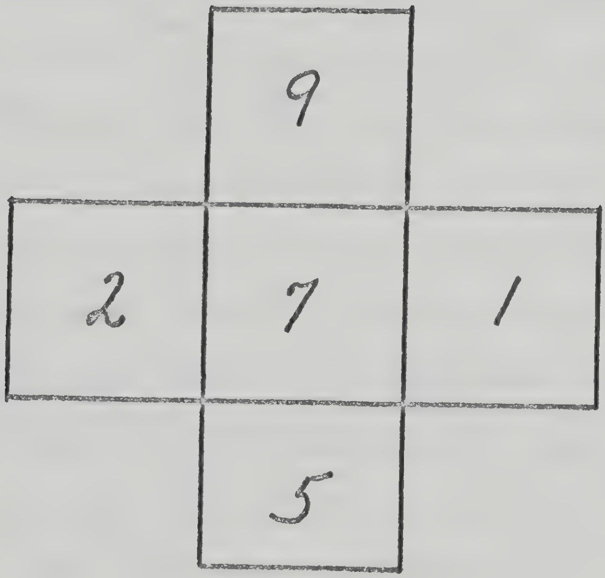

Fig. 6. A Sample Stimulus Grid[a]

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[a]The author is indebted to Drs. E. Howarth and J. Brown (University of Alberta) for the stimulus material.

as possible during the two second retention interval. Recall was written on response sheets which looked like the stimulus grid except that the numbers were missing. One response sheet was used for each grid. The instructions for visual short-term memory are presented in Appendix 5. The stimulus numbers are presented in Appendix 6.

The total test was presented by means of a Kodak Carousel 850 projector which was controlled by a series of three interval timers. The first timer of the cycle was activated when the experimenter pressed a button and presented the word "Ready". After two seconds the stimulus grid was presented for five seconds under the control of the second timer, then the projector changed and the color bars were presented for two seconds. The screen was then blank until the next cycle was activated by the experimenter. Figure 7 graphically depicts the time sequences.

Scoring procedure for this test was quite straightforward. Any number which was correctly recalled in correct position was scored as correct. A total score for each subject was calculated by counting the total number of correct responses.

Experimental Procedure for Cross Modal Coding

The cross modal coding (CMC) task was adapted from Birch and Belmont (1964) and Craviato, Gaona, and Birch (1967) with slight modification. Birch and Belmont, and

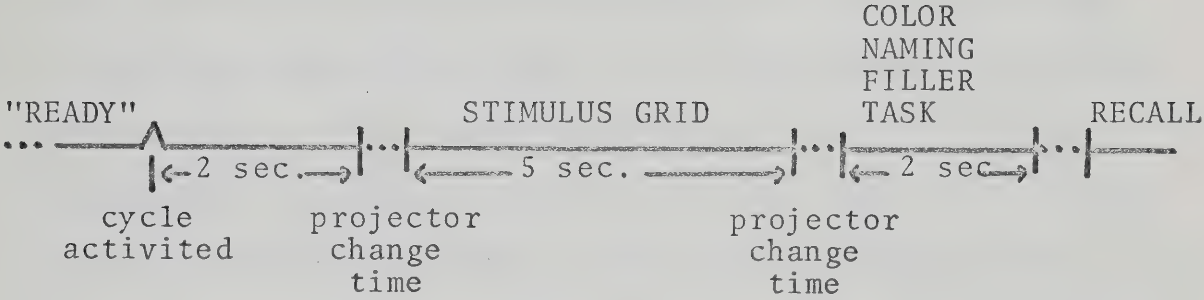

Fig. 7. Time Cycle for Visual Short-Term Memory

Craviato _et al_ used patterns of pencil taps by the experimenter with visual recognition of patterns of sound. The claim was made that this procedure yielded degrees of auditory-visual integration that was related to retardation in reading. However, the problem with the study was that the testing situation was not very well controlled. There were two basic defects. The first defect was that taps were made by the experimenter who presumably had practised the timing of one-half second and one second intervals. The time and volume of the tap variation from one testing situation to another may have been rather large. The other defect which neither Birch and Belmont nor Craviato _et al_ controlled, was that, while the task was supposed to be an auditory-visual integration, the subjects _watched_ the examiner tap out the sequence. The possibility exists then that a visual input mode was operative. Therefore, the task was at least partially a visual-visual integration. Possibly no or little cross modal transfer was, in fact, functioning. These two difficulties were rectified in the current investigation.

In the current study, a standardized testing procedure was accomplished by tape recording the entire test. All the examiner had to do was turn on the tape recorder and present the visual stimuli at the proper times. One thousand cycles per second tones were of 0.15 seconds duration with 0.35 seconds between short pauses and 1.35

seconds between long pauses. The instructions for CMC are presented in Appendix 7. The auditory and visual stimuli are shown in Figure 8.

A total of thirty auditory patterns were presented to each subject. The position of the correct response on the 3" x 5" visual stimuli card was randomly assigned to each of the thirty test items. Each auditory pattern was presented three times, in the same order as is shown in Figure 8.

CMC can not only be thought of as a task in auditory-visual integration, but also as a short term memory task. Viewing the experiment as a STM test, the input mode is auditory which fits nicely into the acoustic nature of the STS but the output mode is visual recognition. Therefore, encoding of stimuli is done to transform the information into a visual mode.

	AUDITORY STIMULI	VISUAL STIMULI		
EXAMPLES				
	. .	..	. .	...
	. ..	...	. ..	.. .
	.. .	...	. ..	.. .
TEST ITEMS				
1	.. ..	. ...	. .. .	.. ..
2	. ...	....	. ...	... .
3	... ..	.....	.. ...	... ..
4	. .. .	. .. .	.....	.. ..
5	... .. .	... .. .	.. ... .	. ... ..
6	.. ...	... ..	.. ...	.... .
7	.. .. ..	.. .. ..	.... ..	... . ..
8	... .	.. ..	... .	... .
9	.. . ...	.. .. ..	.. . ...	.. ... .
10	. ... ..	. .. ...	. ... ..	.. . ...

Fig. 8. Auditory and Visual Test Stimuli, Large and Small Spaces Represent Approximate Time Intervals of 1.35 Sec. and .35 Secs., Respectively. Correct Choices were not Underlined on the Test Cards.

CHAPTER IV

RESULTS AND FINDINGS

Presented in this chapter are the results and findings of this investigation. The results of each test are presented along with the correlations between the tests. For each test, an analysis of variance, summary of means, standard deviations, ranges, and a reliability coefficient are presented. A verbal description of the significant findings is also tendered.

Visual Short-Term Memory

The scores of visual short-term memory were calculated by totalling the number of correctly reproduced digits that were recalled in the correct position. The scores ranged from thirteen to eighty-six and were normally distributed. Figure 9 shows the distribution of scores.

The means indicate that the normal IQ, high socio-economic status (SES) group (group 1), recalled more digits than any of the other groups. On the other hand the retarded subjects of high SES recalled the fewest number of digits. In the two low SES groups, the retarded subjects performed slightly poorer than the normal subjects. The performance of retarded and normal subjects then, is more similar within the low SES group than within the high SES group. Means, standard deviations, and range of scores are

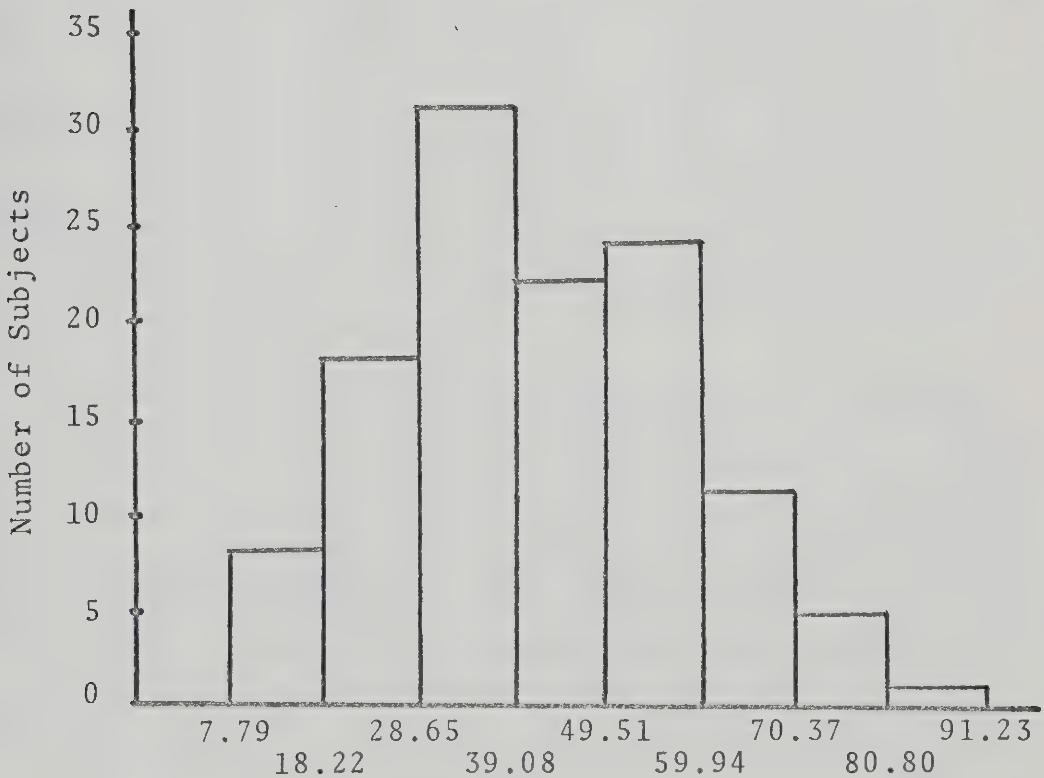

Fig. 9. Distribution of Scores for STMVIS

presented in Table 3.

TABLE 3

VISUAL SHORT-TERM MEMORY (STMVIS): NUMBER OF CORRECTLY REPRODUCED DIGITS

	All Groups	Group			
		High SES Normal	Low SES Normal	High SES Retarded	Low SES Retarded
Mean	17.27	58.43	49.93	37.93	42.77
S.D.	16.43	13.69	15.44	12.51	16.06
Lowest Score	13.00	36.00	18.00	13.00	14.00
Highest Score	86.00	85.00	80.00	73.00	86.00

The visual short-term memory data were analysed in a 2 (IQ Groups) x 2 (SES) analysis of variance (Winer, 1962, p. 228 ff). The first factor was two levels of IQ while the second factor was two levels of socio-economic status (SES). Table 4 is a summary of the analysis of variance.

TABLE 4

SUMMARY TABLE OF ANALYSIS OF VARIANCE FOR VISUAL SHORT-TERM MEMORY

Source	df	Mean Square	F-ratio	P
SES	1	101.00	.46	N.S.
IQ	1	574.10	26.42	$<.001$
IQ x SES	1	133.33	6.14	$<.02$
Error	116	217.30		

There were two findings for visual short-term memory. Firstly, there were significant performance differences between the normal and the retarded subjects. This finding is made more specific by the second finding, a significant IQ x SES interaction. The general finding is that retardates recalled fewer digits than the normals. But among the retardates, the low SES Ss had a higher mean recall than the high SES Ss. This was reversed in the normal group. The performance differences between retarded and MA matched normals were not as great within the low SES groups. Figure 10 is illustrative of these findings. A discussion of the results is presented in Chapter V.

Cross Modal Coding

A total score for each individual was calculated by summing the total number of correctly identified stimuli of the thirty items that were presented. Since there were three response stimuli from which the subject had to choose one, the probability of getting any one item correct is one-third. Therefore a score of ten would represent chance responding. Sixteen out of 120 subjects obtained a score of eleven or less. This could be taken to mean that approximately 10% of the total number of Ss were responding at random. A histogram of the distribution of scores is presented in Figure 11.

The means of cross modal coding show that the two

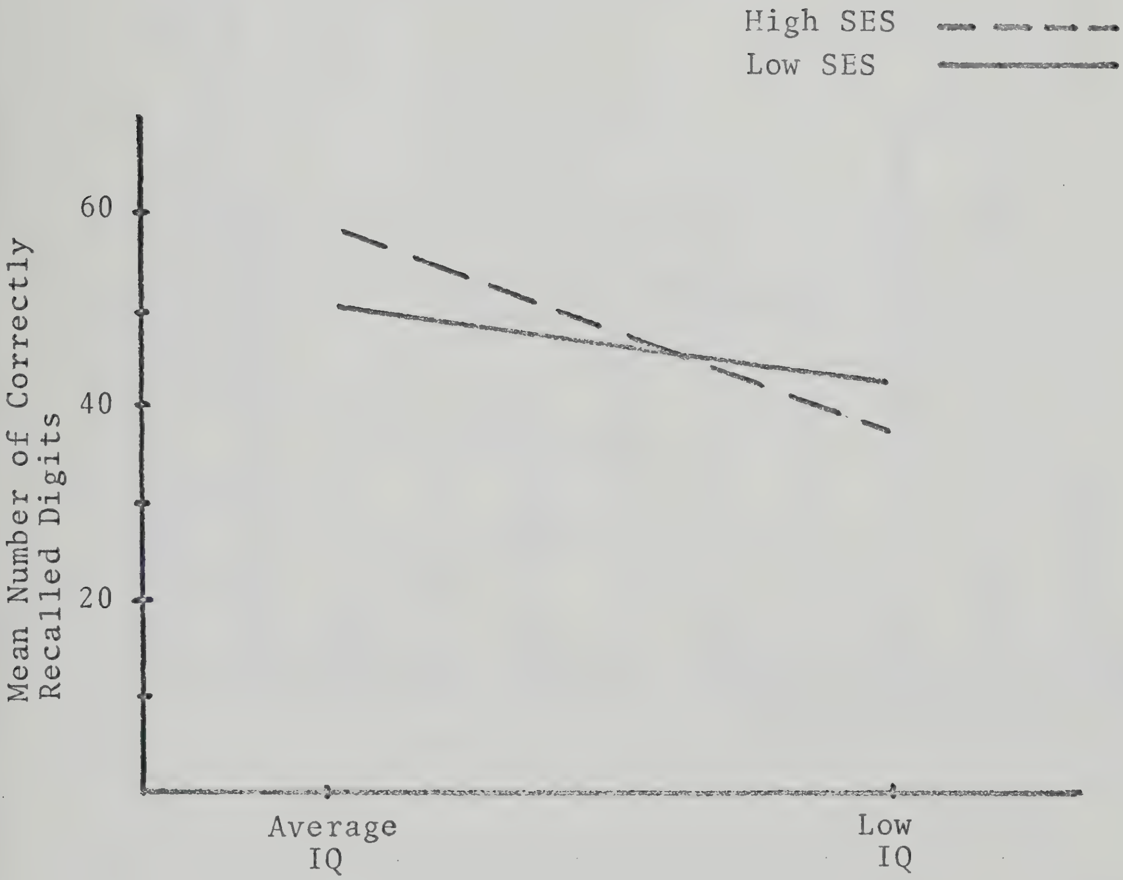

Fig. 10. Means for STMVIS Showing Significant IQ X SES Interaction

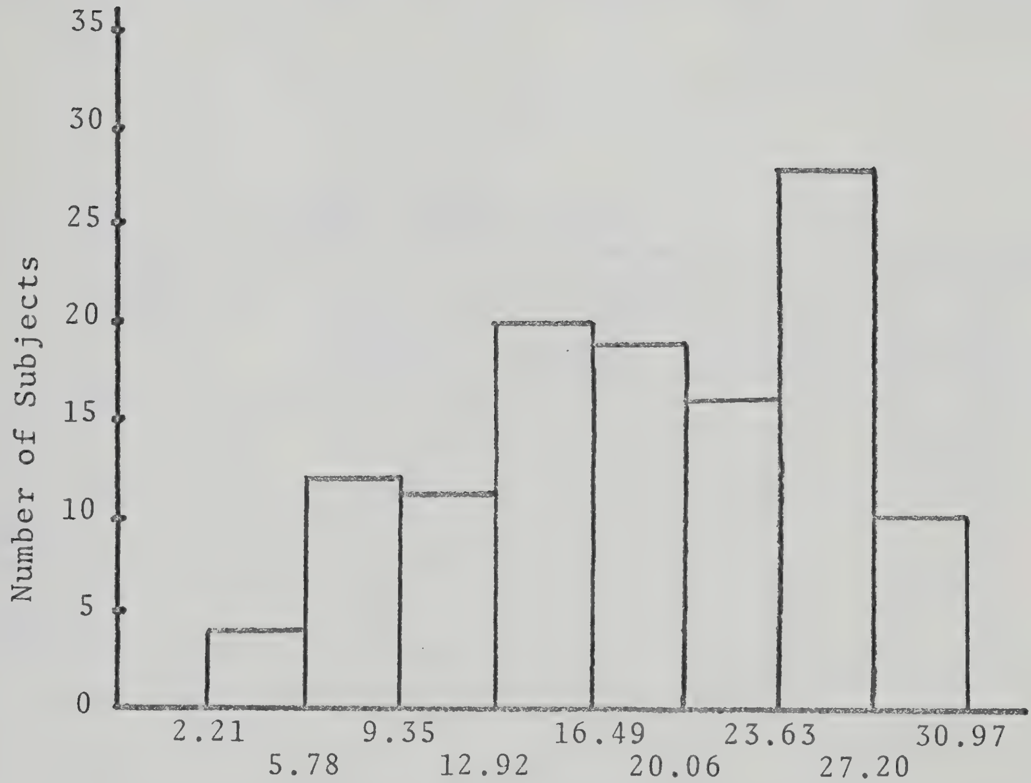

Fig. 11. Distribution of Scores for CMC

high IQ groups obtained higher scores than did the two low IQ groups. It is also interesting to note that in each group, a high score of twenty-nine was obtained by at least one person. A summary of the means, standard deviations and ranges for cross modal coding is presented in Table 5.

TABLE 5

CROSS MODAL CODING

	All Groups	Group			
		High SES Normal	Low SES Normal	High SES Retarded	Low SES Retarded
Mean	20.02	24.17	23.33	15.63	16.97
S.D.	6.69	4.99	4.85	6.86	5.17
Lowest Score	4.00	13.00	10.00	4.00	8.00
Highest Score	29.00	29.00	29.00	29.00	29.00

A 2 x 2 analysis of variance of the total scores for cross modal coding revealed one significant finding. The high IQ group performed better than the low IQ group ($F=52.70$; $df=1,116$; $p < .001$). Socioeconomic differences were not significant although the same cross over between the two low IQ groups was again noticed. Figure 12 graphically shows the results.

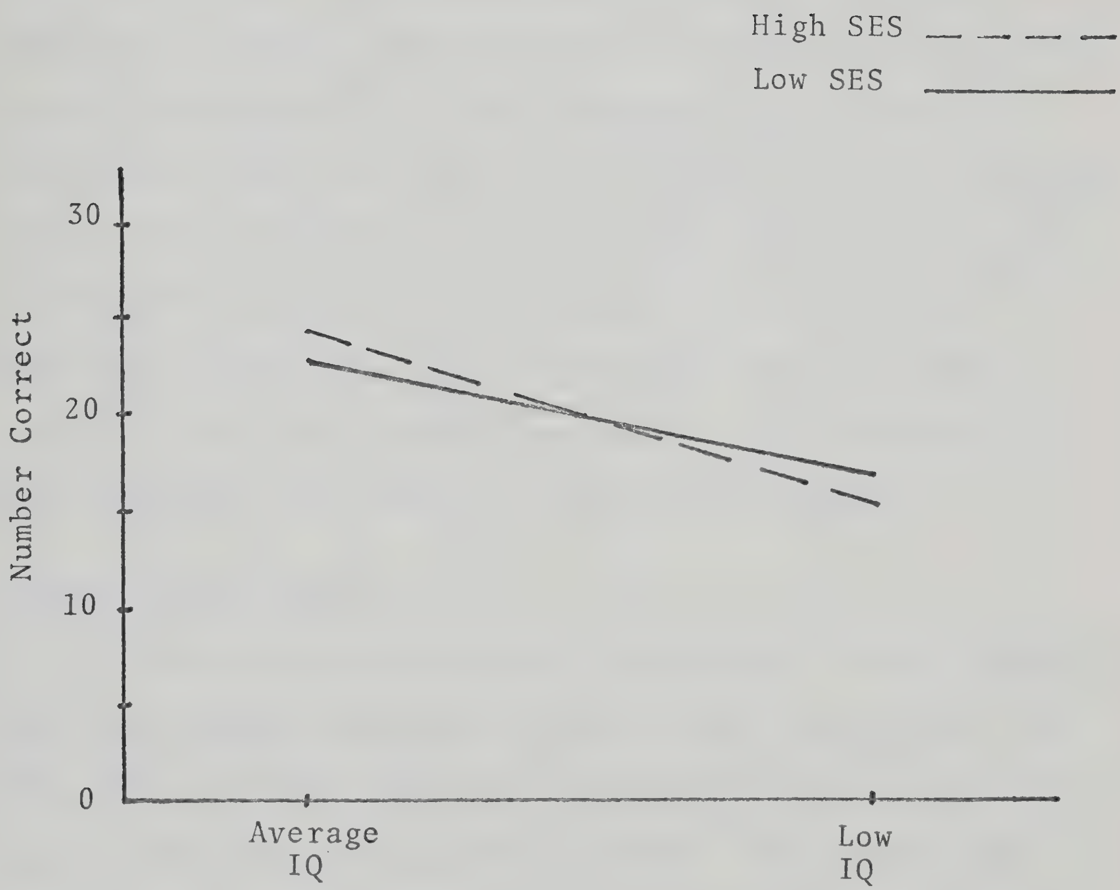

Fig. 12. Number of Correctly Identified Stimuli by Groups for Cross Modal Coding

Auditory Short-Term Memory

The analysis and results for auditory short-term memory are more complex and varied than the results of the other two tests. Four scores were obtained for each individual; control list words and experimental list words scored for free recall, and similarly, two scores were obtained for the two types of word lists scored for serial recall. Since different subjects were used for acoustic and semantic conditions, the results of each will be presented separately. In a subsequent section of the results of auditory short-term memory, the performance of Ss on acoustic and semantic lists will be compared.

Acoustic Free Recall

Two scores for acoustic free recall in the auditory short-term memory task were based on the total number of correctly recalled words for two types of lists, control lists, and acoustically similar lists. In scoring free recall, the order in which the words were reproduced was ignored. The distributions of the scores and the means of the various groups indicate that the control sequences were fairly easy for the high IQ groups. Thus, there is a slight tendency toward a ceiling effect. The standard deviation shows that there was more variability in recall of the acoustic sequences than the control sequences. The means also show that the high IQ groups performed better

than the low IQ groups. A summary of the means, standard deviations, and ranges is presented in Table 6. A histogram of the distribution of scores is presented in Figure 13.

TABLE 6

STM-AUDITORY: ACOUSTIC FREE RECALL

		All Groups	Group			
			High SES Normal	Low SES Normal	High SES Retarded	Low SES Retarded
Mean	Control	40.03	44.93	43.53	36.66	35.00
	Exper.	32.97	41.73	40.93	25.80	23.39
S.D.	Control	6.81	3.54	3.64	6.42	7.33
	Exper.	12.39	7.18	5.59	13.02	10.13
Highest Score	Control	48.00	48.00	48.00	48.00	43.00
	Exper.	48.00	48.00	48.00	47.00	37.00
Lowest Score	Control	22.00	39.00	35.00	26.00	22.00
	Exper.	5.00	21.00	28.00	5.00	5.00

The data were analysed in a 2 (IQ groups) x 2 (SES) x 2 (word lists) analysis of variance (Winer, 1962, p. 348 ff); the last factor was a repeated measure. Basically there were three findings: (1) normal IQ subjects had better recall than retarded Ss; (2) control words were recalled more frequently than were acoustic words; and, (3) acoustic interference affected the retardates more than the normals

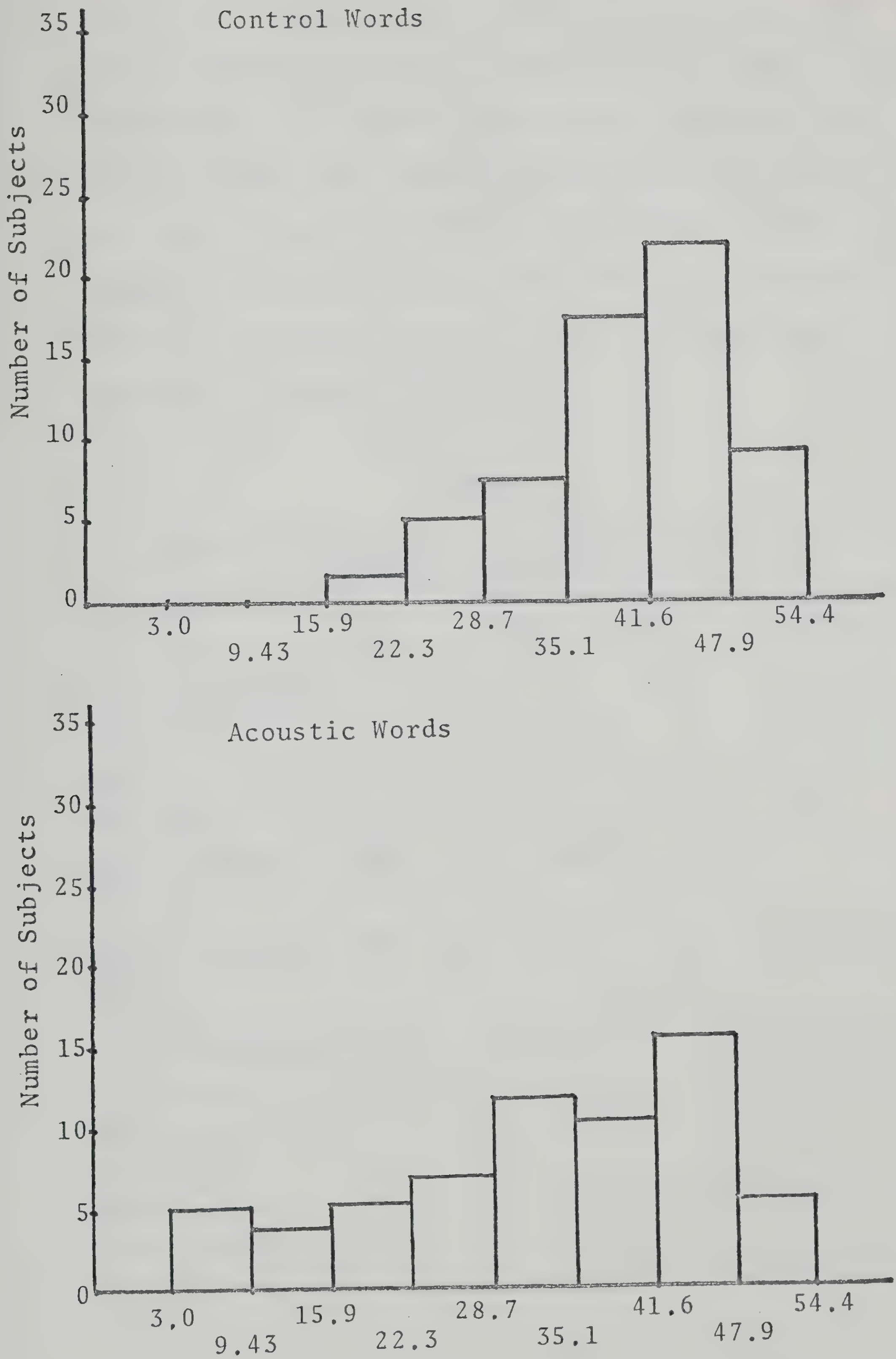

Fig. 13. Distribution of Scores for Acoustic Free Recall

(IQ x Words interaction). The latter finding makes the results more specific and clarifies the nature of the differences. In general, retardates recalled fewer acoustic words than control words, whereas, recall of the two types of word lists was more similar for the normals. A summary of this analysis of variance is presented in Table 7. A graphic representation of these results is presented in Figure 14.

TABLE 7

SUMMARY OF ANALYSIS OF VARIANCE STM AUDITORY: ACOUSTIC FREE RECALL

Source	df	Mean Square	F-ratio	P
Between Subjects	59			
IQ	1	4737.63	46.96	$<.001$
SES	1	73.62	0.73	N.S.
IQ x SES	1	6.50	.06	N.S.
Error Between	56	100.88		
Within Subjects	60			
Words:				
Control vs Experimental	1	1498.12	83.18	$<.001$
IQ x Words	1	520.80	28.92	$<.001$
SES x Words	1	0.10	0.01	N.S.
IQ x SES x Words	1	3.44	0.19	N.S.
Error Within	56	18.01		

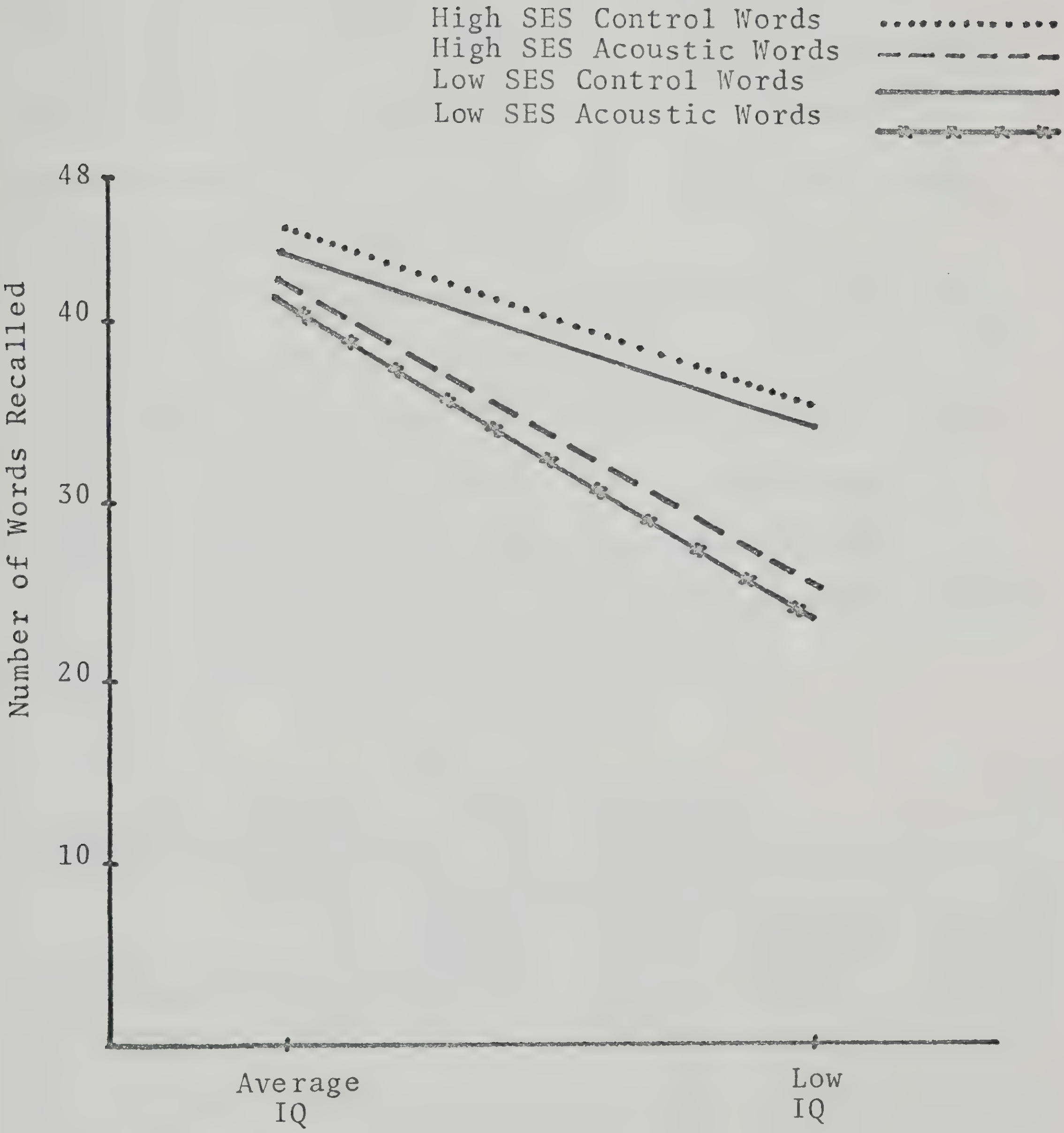

Fig. 14. Number of Words Recalled by Groups

Semantic Free Recall

The semantic free recall results are similar to those of acoustic free recall even though a different group of subjects was involved. The control lists had a higher recall score than the acoustic word lists. The semantic words fall in between, and were slightly easier to recall than the acoustic words.

Some of the means for semantic free recall are different than for acoustic free recall. The main difference is that group 4 (Low SES, retarded) recalled nearly as many control words as either of the two average IQ groups. A summary of the means, standard deviations and ranges is presented in Table 8. A histogram of the distribution of scores is shown in Figure 15.

TABLE 8

STM AUDITORY: SEMANTIC FREE RECALL

		All Groups	Group			
			High SES Normal	Low SES Normal	High SES Retarded	Low SES Retarded
Mean	Control	40.10	41.73	41.07	37.27	40.33
	Exper.	33.07	38.73	34.60	27.07	31.87
S.D.	Control	6.21	7.43	5.40	5.56	6.10
	Exper.	10.84	10.53	6.54	10.12	13.05
Highest Score	Control	48.00	48.00	47.00	44.00	47.00
	Exper.	48.00	48.00	43.00	42.00	47.00
Lowest Score	Control	23.00	23.00	23.00	26.00	28.00
	Exper.	9.00	9.00	21.00	12.00	11.00

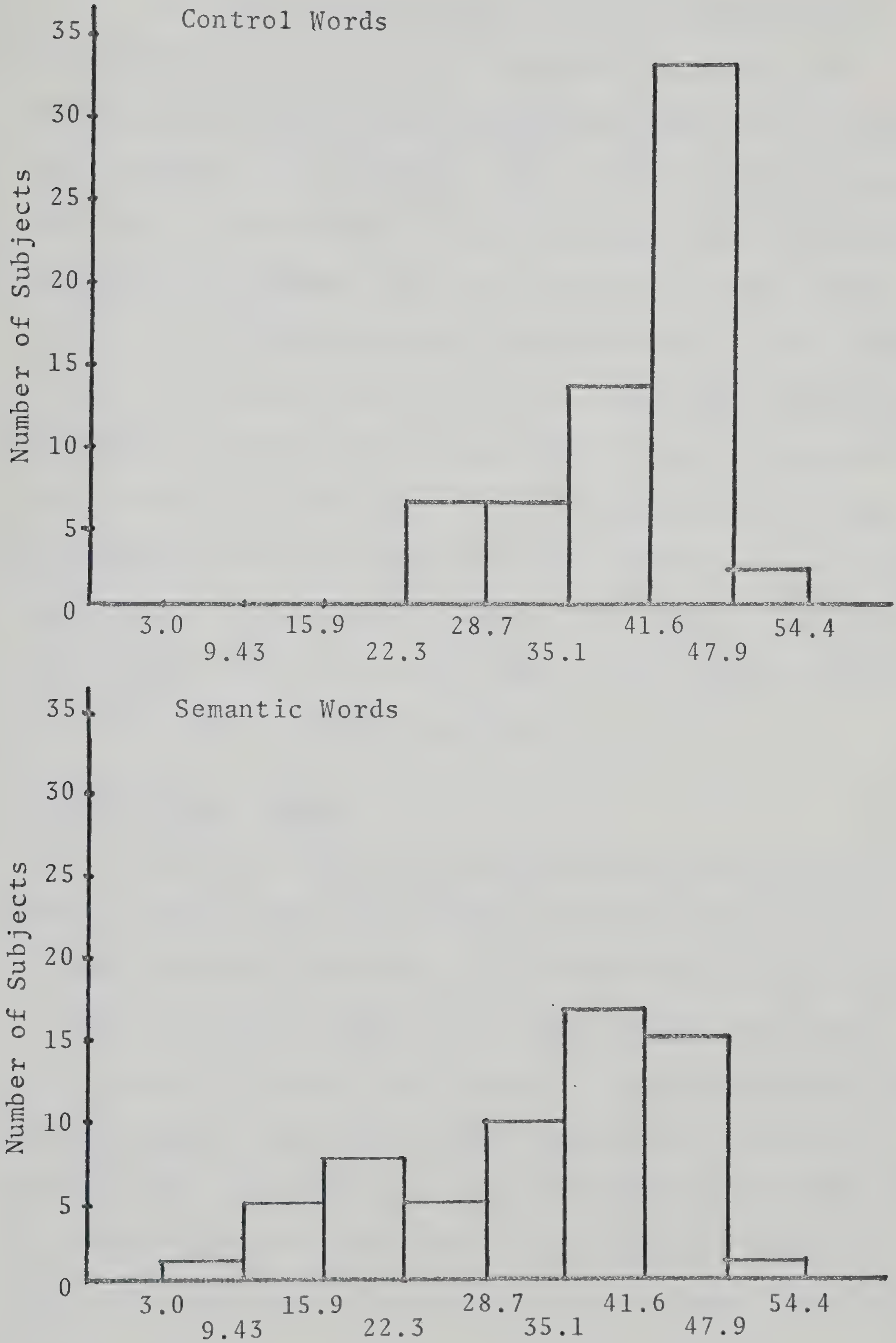

Figure 15. Distribution of Scores for Semantic Free Recall

The analysis of variance used was identical to the previous one: a 2 x 2 x 2 analysis with the last factor a within subjects, repeated measure. The findings are the same as for acoustic free recall with the exception that the IQ differences are not as pronounced. The findings are clarified by the significant IQ x Words interaction. IQ differences are relatively weak. The tendency is that on control lists there is little difference between high and low IQ subjects. But where semantic intra-list interference is operative, the retardates perform less adequately. Table 9 summarizes the analysis of variance and Figure 16 graphically displays the means. The cross over between the two low IQ groups emerges again, although it is not statistically significant.

Acoustic Serial Recall

Scoring retention according to serial recall was done by summing the total number of words that were recalled in their correct position. It differs from the free recall in that it is more rigorous, because of the additional order demand placed on the subject. Therefore unlike free recall scores, the serial recall scores for the experimental lists (see Figure 17) were concentrated at the lower end of the distribution. Five individuals of group 3 (High SES, Retarded) obtained a score of three, four, or five.

TABLE 9

SUMMARY OF ANALYSIS OF VARIANCE STM AUDITORY:
SEMANTIC FREE RECALL

Source	df	Mean Square	F-ratio	P
Between Subjects	59			
IQ	1	720.37	5.64	$<.021$
SES	1	17.69	0.14	N.S.
IQ x SES	1	300.75	2.36	N.S.
Error Between	56	127.61		
Within Subjects	60			
Words:				
Control vs Experimental	1	1480.06	86.31	$<.001$
IQ x Words	1	158.62	9.22	$<.01$
SES x Words	1	5.62	0.33	N.S.
IQ x SES x Words	1	50.75	2.95	N.S.
Error Within	56	17.20		

The means show that the two average IQ groups scored better than the two retarded groups. Furthermore the acoustic words were recalled less perfectly than the control words. The means, standard deviations and ranges are summarized in Table 10 on page 75.

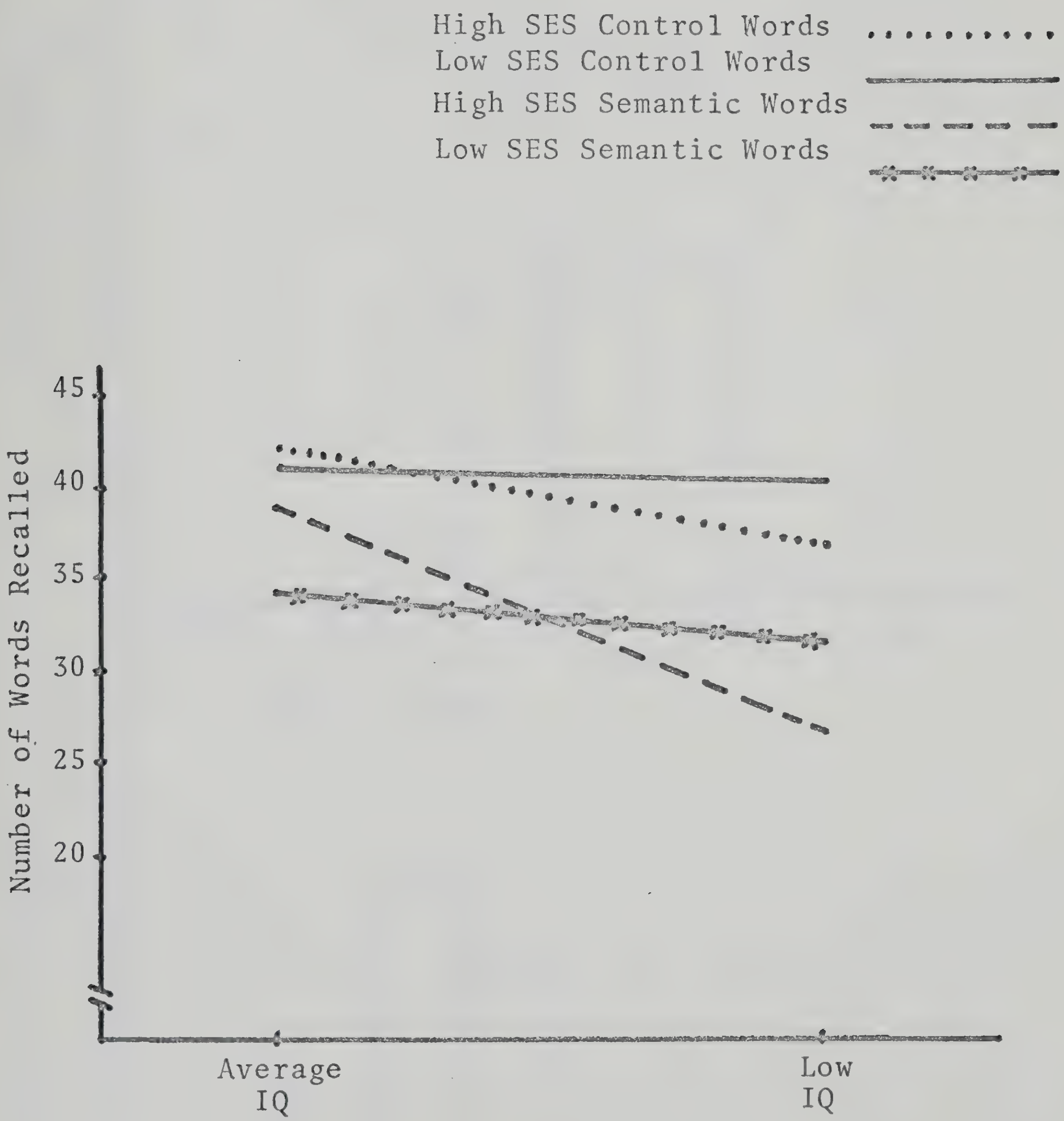

Fig. 16. Number of Words Recalled in Semantic Free Recall

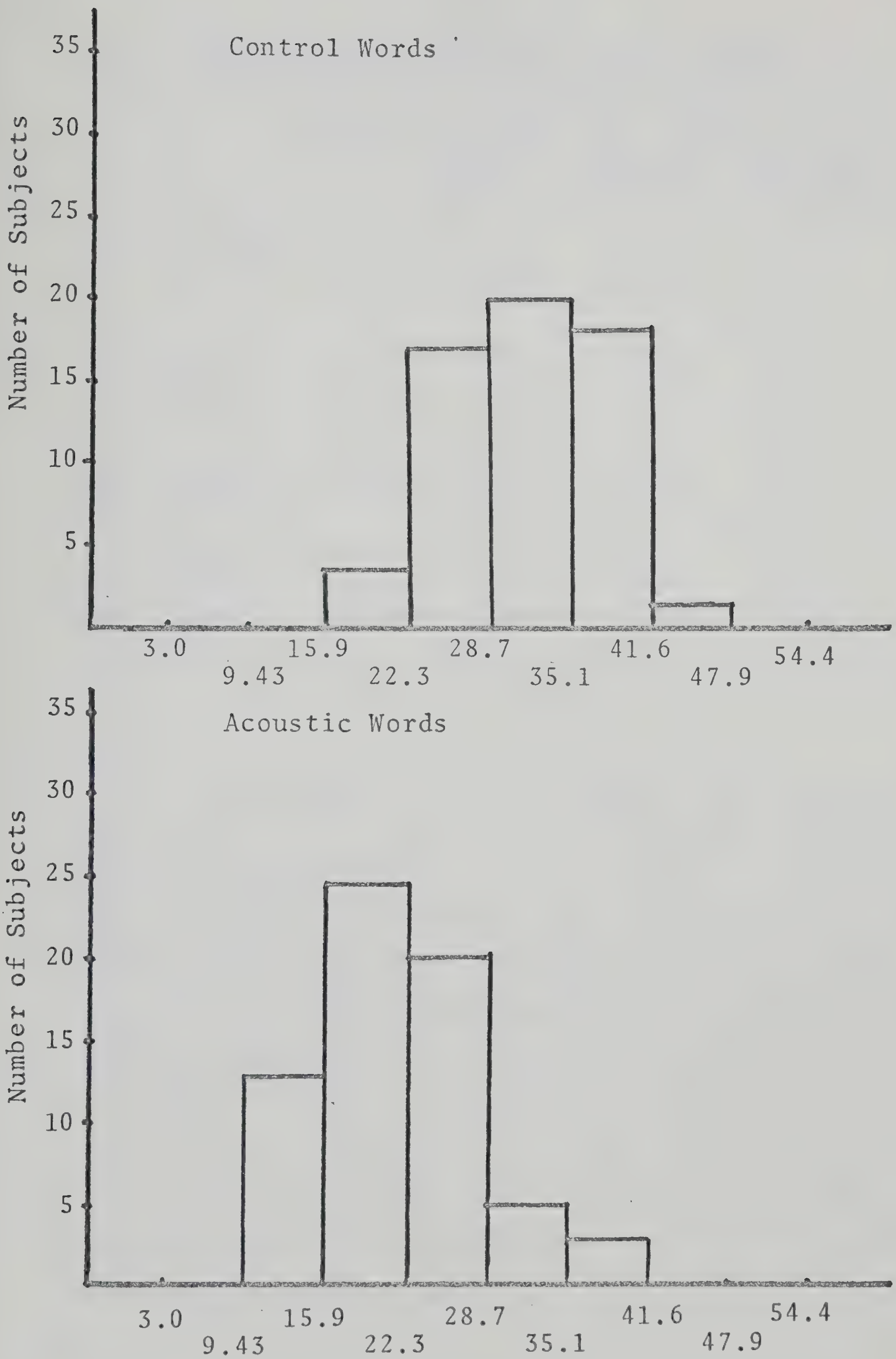

Fig. 17. Distribution of Scores for Acoustic Serial Recall

TABLE 10

STM AUDITORY: ACOUSTIC SERIAL RECALL

		All Groups	Group			
			High SES Normal	Low SES Normal	High SES Retarded	Low SES Retarded
Mean	Control	25.03	29.67	26.07	20.73	23.67
	Exper.	14.72	18.53	18.07	10.27	12.00
S.D.	Control	6.39	5.64	6.16	6.24	4.50
	Exper.	6.61	5.88	7.12	5.57	3.74
Highest Score	Control	36.00	36.00	35.00	32.00	31.00
	Exper.	31.00	29.00	31.00	20.00	19.00
Lowest Score	Control	11.00	17.00	15.00	11.00	16.00
	Exper.	3.00	11.00	7.00	3.00	8.00

As before, a 2 x 2 x 2 analysis of variance, with the last factor a within subjects repeated measure, was used to summarize the data. There were two major findings: normal subjects had superior performance to retarded subjects, and control words were recalled more frequently than acoustic words. The analysis of variance is presented in Table 11. The mean recall scores of the four groups for the control and acoustic lists are plotted in Figure 18. The cross over effects appears to be a constant feature in this and the previous graphs.

TABLE 11

SUMMARY OF ANALYSIS OF VARIANCE STM AUDITORY: ACOUSTIC SERIAL RECALL

Source	df	Mean Square	F-ratio	P
Between Subjects	59			
IQ	1	1235.21	22.97	$<.001$
SES	1	0.67	0.01	N.S.
IQ x SES	1	143.01	2.66	N.S.
Error Between	56	53.78		
Within Subjects	60			
Words	1	3193.01	290.08	$<.001$
IQ x Words	1	16.88	1.53	N.S.
SES x Words	1	7.01	0.64	N.S.
IQ x SES x Words	1	35.26	3.20	N.S.
Error Within	56	11.01		

Semantic Serial Recall

The distribution of scores of the control words are similar to semantic free recall. The experimental semantic words were distributed reasonably evenly across the range of scores. Figure 19 on page 78 shows the distribution of scores.

The analysis of variance used for this method of scoring was the same as for semantic serial recall.

There are several findings for this experiment which are of major interest. Firstly, average IQ subjects

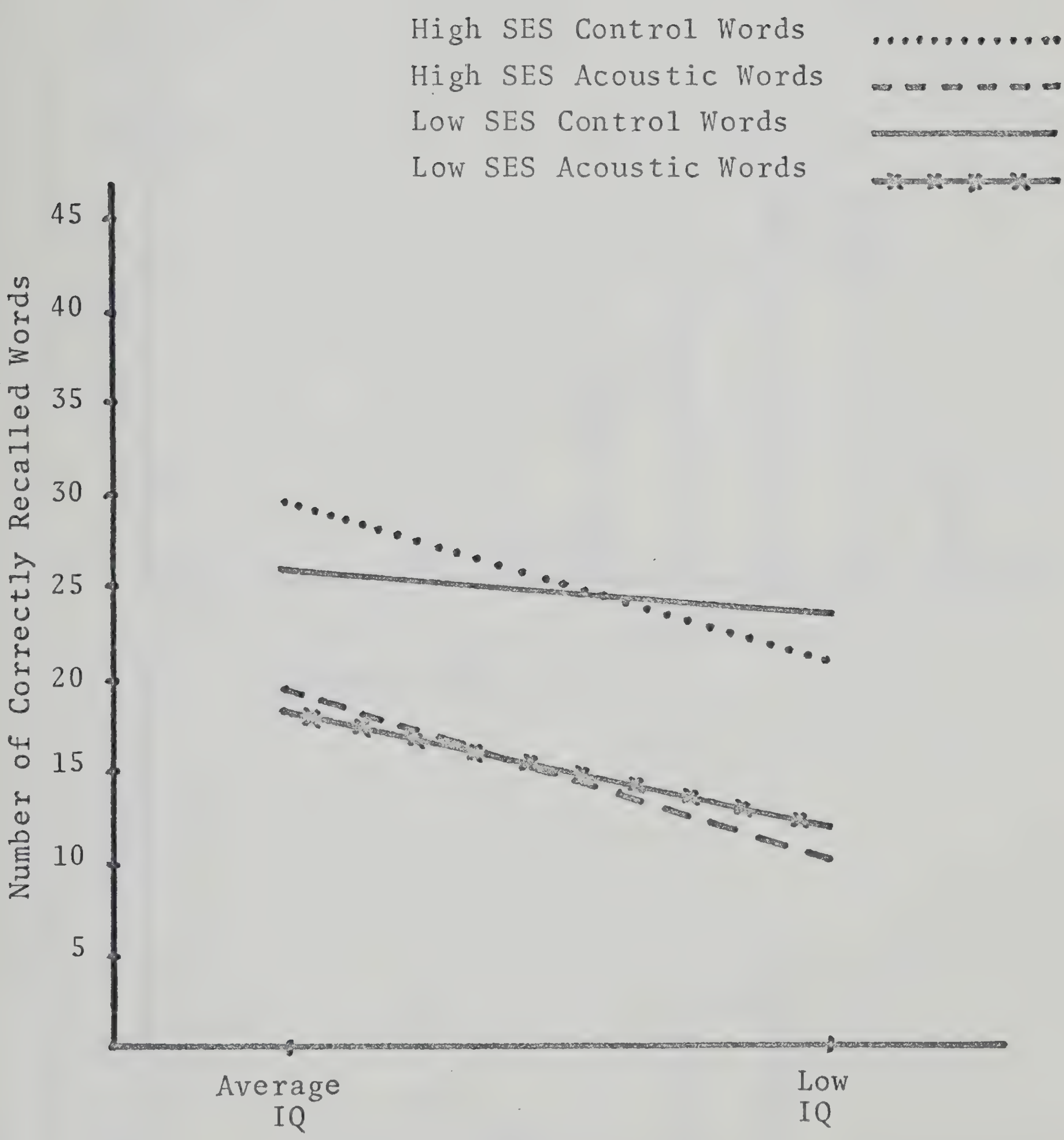

Fig. 18. Number of Words Recalled in Acoustic Serial Recall

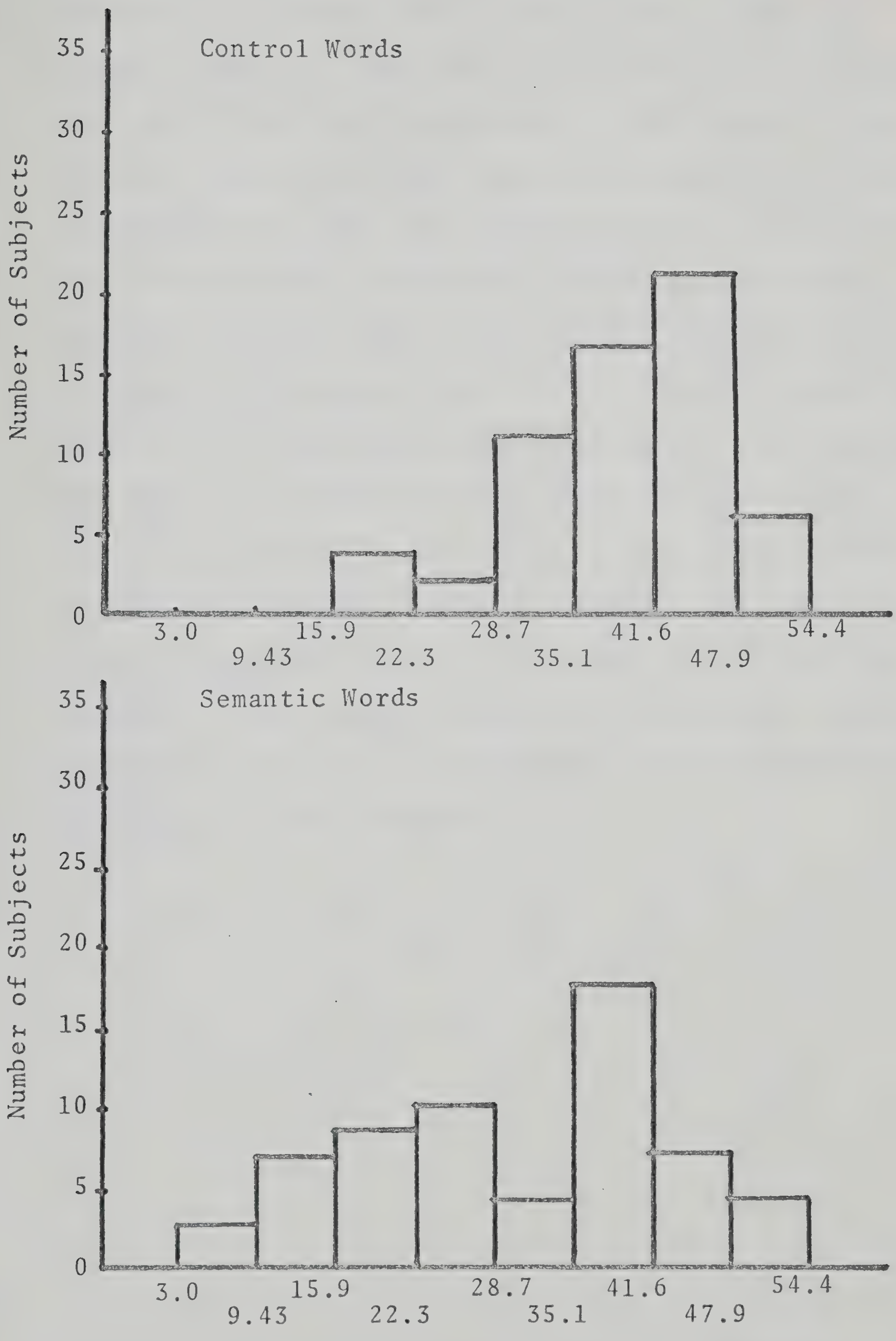

Fig. 19. Distribution of Scores for Semantic Serial Recall

performed at a higher level than did the MA matched retarded subjects. Secondly, performance on the control words was better than performance on the semantic words. However, three significant interactions call for specific interpretations. The IQ x Words interaction shows that intra-list semantic interference had a greater effect with the retarded subjects than it did with the non-retarded subjects. Furthermore, the IQ x SES x Words interaction shows that the high SES retarded group had poorer performance than the low SES retarded group both on control as well as on semantic words. This is also noted in the IQ x SES interaction. Table 12 presents the analysis of variance and Figure 20 is illustrative of the findings. A summary of the means, standard deviations and ranges is included in Table 13. A discussion of these findings is included in a later chapter.

TABLE 12

SUMMARY OF ANALYSIS OF VARIANCE STM AUDITORY:
SEMANTIC SERIAL RECALL

Source	df	Mean Square	F-ratio	P
Between Subjects	59			
IQ	1	1569.62	9.22	<.01
SES	1	13.31	0.08	N.S.
IQ x SES	1	740.06	4.35	<.01
Error Between	56	170.21		
Within Subjects	60			
Words	1	2184.50	128.05	<.001
IQ x Words	1	229.69	13.46	<.001
SES x Words	1	6.56	0.38	N.S.
IQ x SES x Words	1	123.94	7.27	<.01
Error Within	56	17.06		

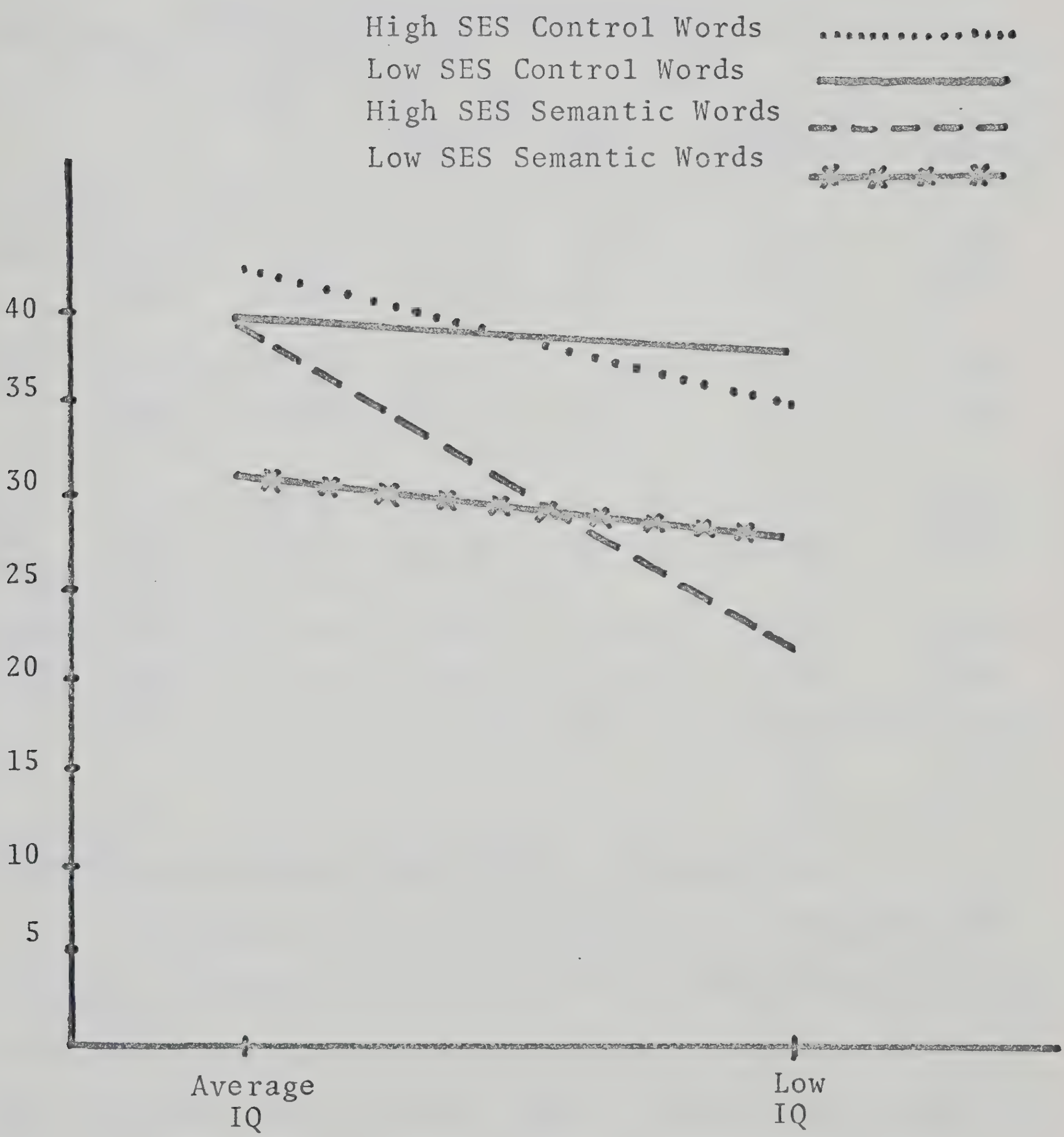

Fig. 20. Mean Number of Words Recalled in Semantic Serial Recall

TABLE 13

STMAUD SEMANTIC SERIAL RECALL

		All Groups	Group			
			High SES Normal	Low SES Normal	High SES Retarded	Low SES Retarded
Mean	Control	38.67	42.47	39.33	35.07	37.80
	Exper.	30.13	39.20	31.07	22.20	28.06
S.D.	Control	7.70	7.42	6.99	6.79	8.58
	Exper.	12.66	10.20	11.27	9.28	14.43
Highest Score	Control	48.00	48.00	47.00	46.00	47.00
	Exper.	48.00	48.00	47.00	40.00	45.00
Lowest Score	Control	17.00	21.00	20.00	24.00	17.00
	Exper.	3.00	10.00	12.00	5.00	3.00

Acoustic and Semantic Free Recall: A Comparison

The purpose of this analysis was to determine the relative interference value of acoustic and semantic lists. The analysis of variance presented in Table 14 is a bit more detailed than in either Table 7 or Table 9 in that it combines the acoustic and semantic experiments in free recall. The type of interference is treated as another factor between subjects in the factorial 2 (IQ) x 2 (SES) x 2 (interference) x 2 (control/experimental) analysis of

TABLE 14

ANALYSIS OF VARIANCE OF FREE RECALL ACOUSTIC AND SEMANTIC

Source	df	Mean Square	F-ratio	P
Between Subjects	119			
IQ	1	4576.27	40.28	<.01
SES	1	9.60	0.08	N.S.
Interference (I)	1	0.27	0.00	N.S.
IQ x SES	1	112.07	0.99	N.S.
IQ x I	1	881.67	7.76	<.01
SES x I	1	81.67	0.72	N.S.
IQ x SES x I	1	201.67	1.77	N.S.
Error Between	112	113.62		
Within Subjects	120			
Words: Control vs Experimental	1	2982.15	165.67	<.01
IQ x Words	1	633.75	35.21	<.01
SES x Words	1	2.82	0.16	N.S.
I x Words	1	0.02	0.00	N.S.
IQ x SES x Words	1	14.02	0.78	N.S.
IQ x I x Words	1	50.42	2.80	N.S.
SES x I x Words	1	2.02	0.11	N.S.
IQ x SES x I x Words	1	40.02	2.22	N.S.
Error Within	112	18.00		

variance design (Winer, 1962, p. 350 ff) where the last factor is a within subjects repeated measure.

In this analysis, like most of the other analyses, the retarded subjects as a group performed more poorly than the average IQ subjects. However, there are two interactions which qualify this main effect. It was found that acoustic similarity was more interfering in the low IQ group than in the high IQ group. The interference from semantic similarity was less striking. When the results of the Control words and Experimental words are examined in relationship to low and average IQ groups, it becomes apparent that the retarded subjects are more susceptible to interference than are the average IQ subjects. Furthermore, it was found that control words were, on the average, retained better by all groups than were either of the two types of experimental words. These results are presented in Figures 21 and 22.

Acoustic and Semantic Serial Recall: A Comparison

The serial recall scores seem to be more sensitive to differences between groups and between procedures than is the free recall method of scoring. One obvious explanation is that with serial order recall, more of an individual's capacity is used in retaining the words in their appropriate serial position. This adds to the task difficulty and tends to emphasize differences where they exist.

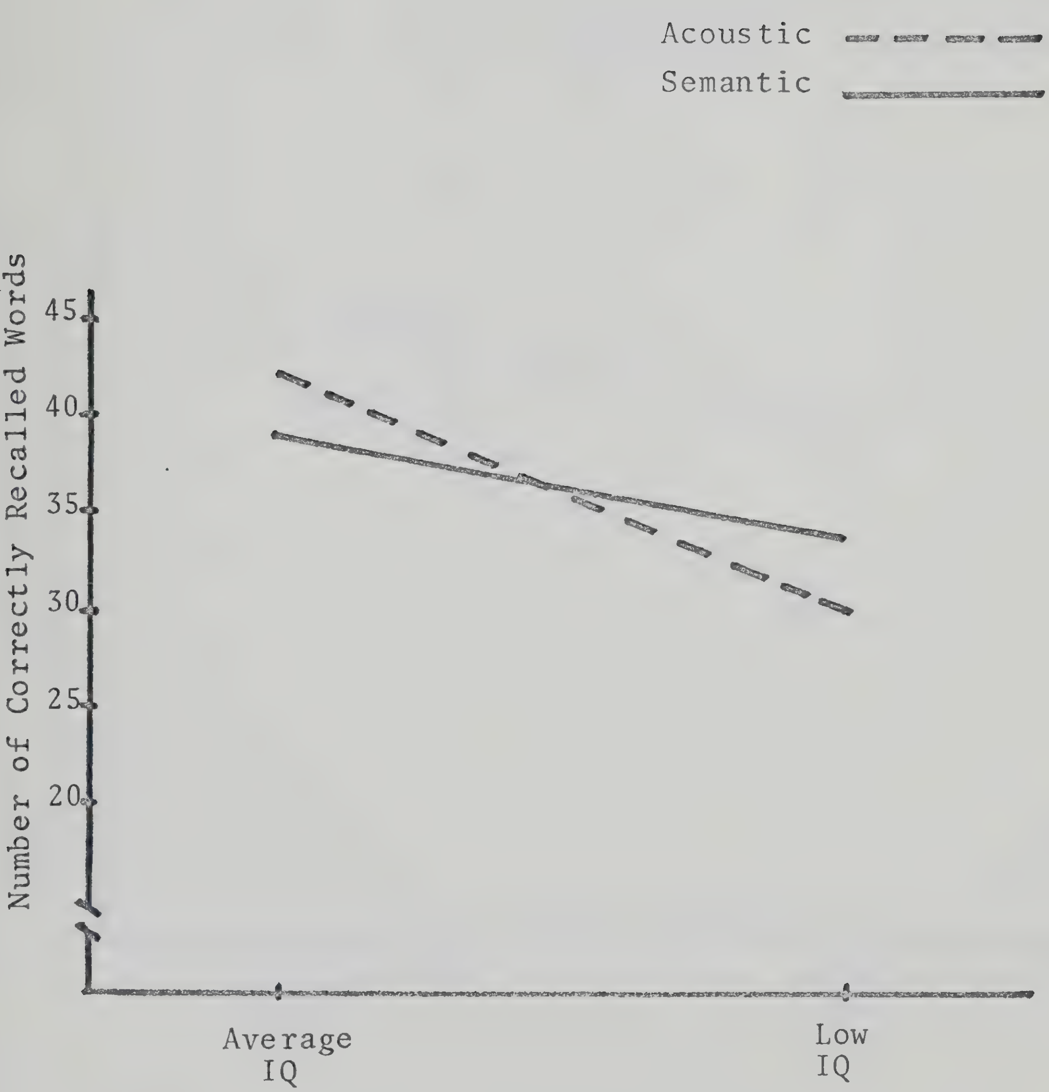

Fig. 21. Interaction Between IQ and Type of Interference

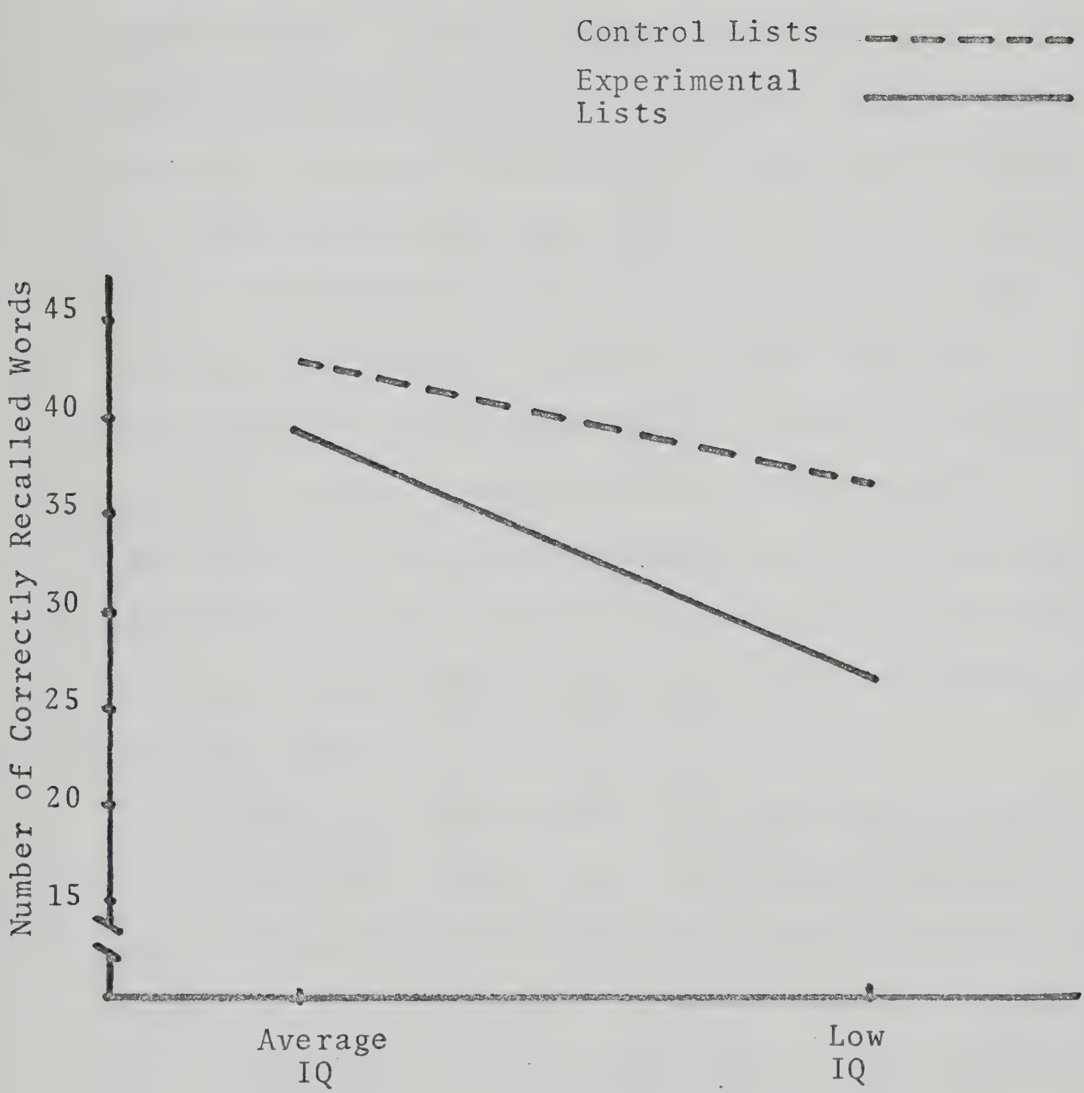

Fig. 22. Interaction Between IQ and Word Type (Similarity vs no Similarity)

The analysis considers the differences between acoustic and semantic recall (interference) as another between subjects factor, and is thus identical to the analysis for free recall. It is presented in Table 15. There are several interesting findings here. First, there are three significant main effects. The performance of average IQ subjects is better than the performance of low IQ subjects; semantic condition words (both control and experimental) were recalled with a greater frequency than acoustic control and experimental word sequences; and, control words were recalled with a greater frequency than experimental words. However, as before, several significant interaction effects qualify the interpretation of the main effects.

The first interaction of importance is the IQ x SES interaction (Figure 23). Low SES, normal subjects (group 2) performed slightly more poorly than high SES normal subjects (group 1). However, in the retarded group, the low SES subjects performed better than their high SES counterparts, as before.

The IQ x Words interaction can be interpreted in a similar way. The retarded, as a group, performed more poorly on experimental lists where intra-list interference was operative (Figure 24). Again, however, the above findings need to be further qualified by the three and four factor interactions.

TABLE 15

ANALYSIS OF VARIANCE OF SERIAL RECALL ACOUSTIC AND SEMANTIC

Source	df	Mean Square	F-ratio	P
Between Subjects	119			
IQ	1	2760.82	24.75	<.01
SES	1	2.82	0.03	N.S.
Interference (I)	1	12731.27	114.11	<.01
IQ x SES	1	784.82	7.03	<.05
IQ x I	1	8.07	0.07	N.S.
SES x I	1	8.07	0.07	N.S.
IQ x SES x I	1	123.27	1.10	N.S.
Error Between	112	111.57		
Within Subjects	120			
Words: Control vs Experimental	1	5377.07	366.17	<.01
IQ x Words	1	194.4	13.24	<.01
SES x Words	1	0.07	0.00	N.S.
I x Words	1	43.35	2.95	N.S.
IQ x SES x Words	1	11.26	0.77	N.S.
IQ x I x Words	1	66.15	4.50	<.05
SES x I x Words	1	16.02	1.09	N.S.
IQ x SES x I x Words	1	138.01	9.40	<.01
Error Within	112	14.68		

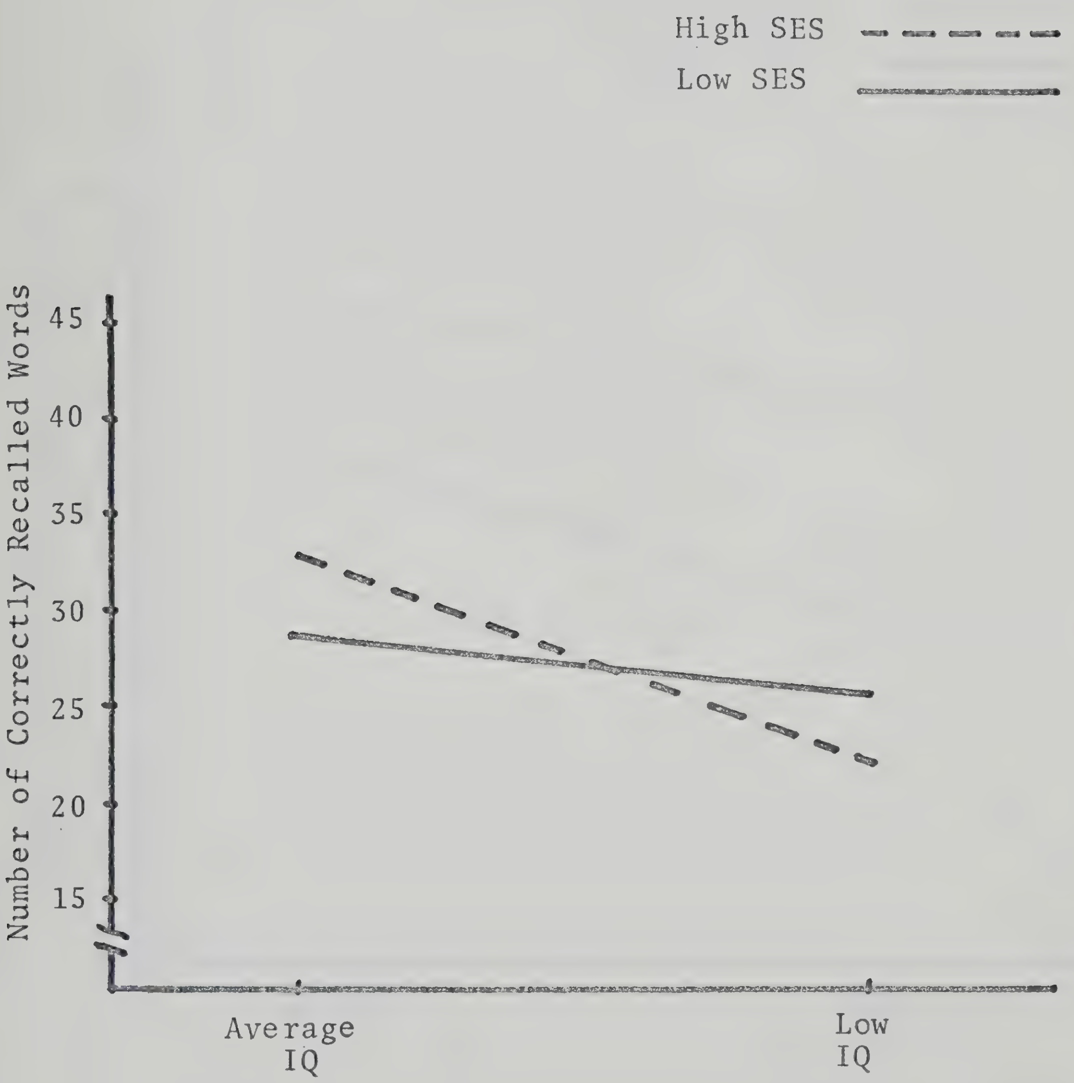

Fig. 23. Interaction Between IQ and SES Serial Recall

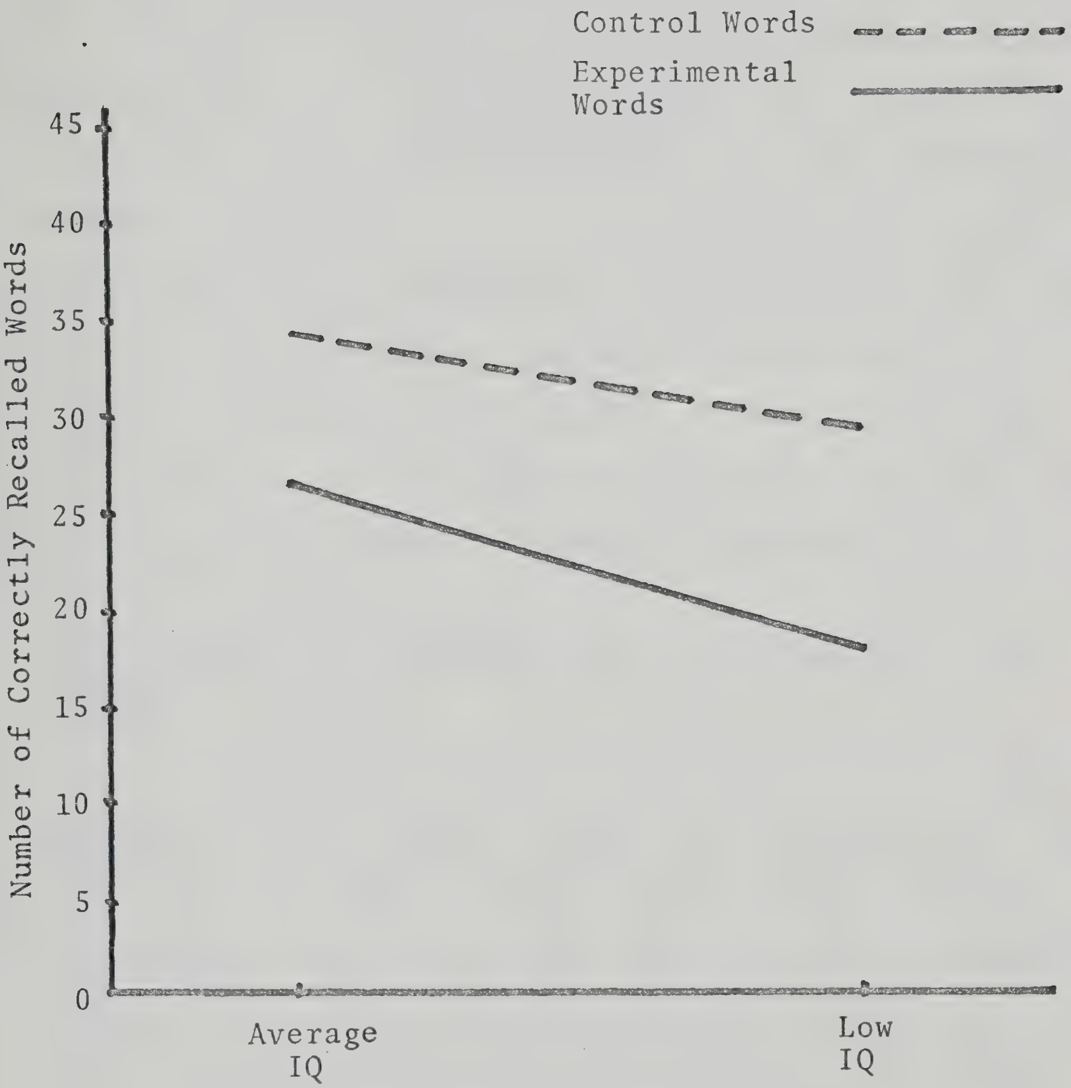

Fig. 24. Interaction Between IQ and Word Type (Similarity vs no Similarity)

The three factor interaction of IQ x I (interference) x Words shows that retarded Ss were more affected by interference on the experimental lists than the normal Ss especially on the acoustic sequences. Figure 25 is representative of this interaction. On the other hand, the most interesting finding is represented in Figure 26 which graphically displays the IQ x SES x I x Words interaction. The high SES, retarded group was most affected by semantic intra-list interference in comparison to the performance of all the other groups on all the other tasks. The implication of this finding is discussed in Chapter V.

Control Words: A Comparison of the Performance of Two Samples

Another interesting result can be shown from a comparison of the control words which were not only the same words but also the same sequence of control and experimental lists were used. Therefore if there is a difference between the control words, it would be a function of the proactive and retroactive inhibition effects of the experimental words.

In two separate 2 (IQ) x 2 (SES) x 2 (Acoustic/Semantic) analyses of variance, the last factor was a between subjects factor of acoustic and semantic. The first analysis of variance on free recall showed no differences between acoustic and semantic control words. However in serial recall, acoustic control lists were

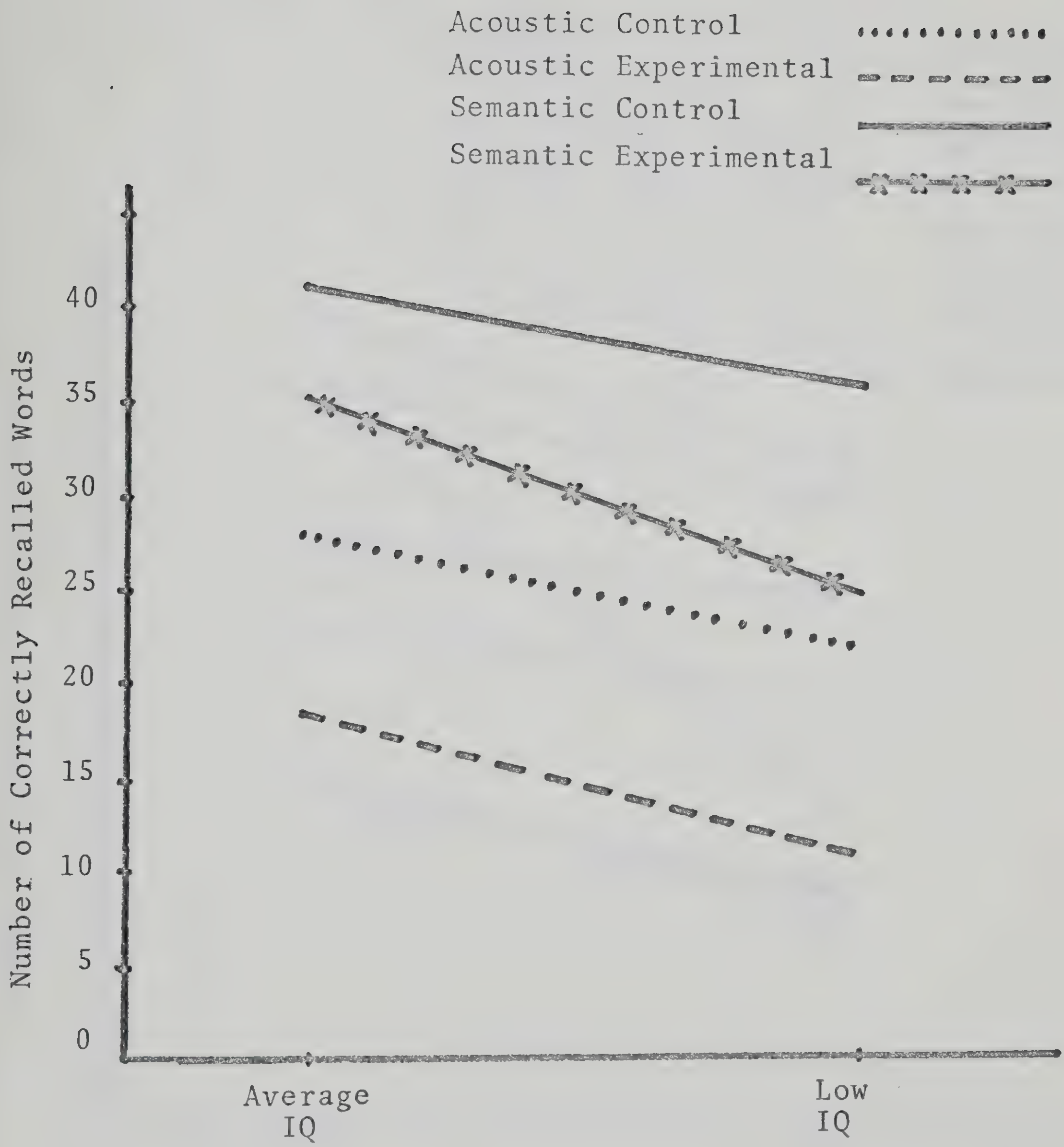

Fig. 25. Three-Way Interaction Between IQ, Interference and Words

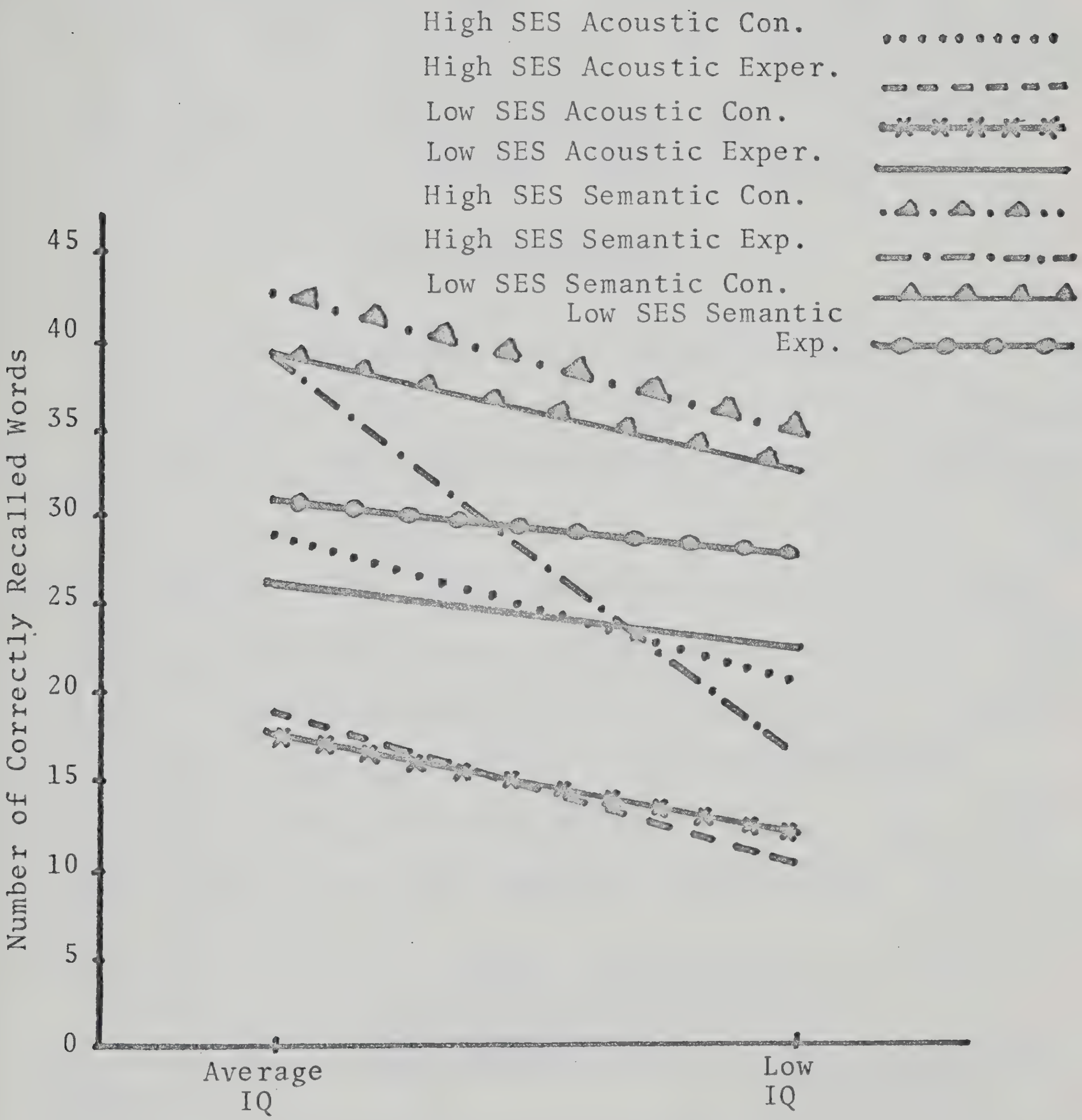

Fig. 26. Four-Way Interaction of IQ x Sex x I x Words

recalled less frequently than semantic control lists ($F = 126.55$; $df = 1,112$; $p < .0001$). This finding indicates that in serial recall, acoustic within-list interference carried over to become between-list interference. The results of this analysis are graphically displayed in Figure 27.

Test Reliabilities

Test reliability was calculated differently for each of the separate tests. A split-half reliability coefficient corrected for test length (Ferguson, 1959, p. 279-280) was used for visual short-term memory. For cross-modal coding, the average of the intercorrelations of the three presentations of the test items was used as an estimate of reliability. The reliability of the auditory short-term memory tasks was calculated according to the Spearman-Brown prophecy formula presented in Winer (1960, p. 127). The test reliabilities are summarized in Table 16.

TABLE 16

TEST RELIABILITIES

Test	Reliability Coefficient
Visual short-term memory	0.80
Cross-modal coding	0.72
Auditory short-term memory	
Acoustic free recall	0.82
Semantic free recall	0.87
Acoustic serial recall	0.79
Semantic serial recall	0.90

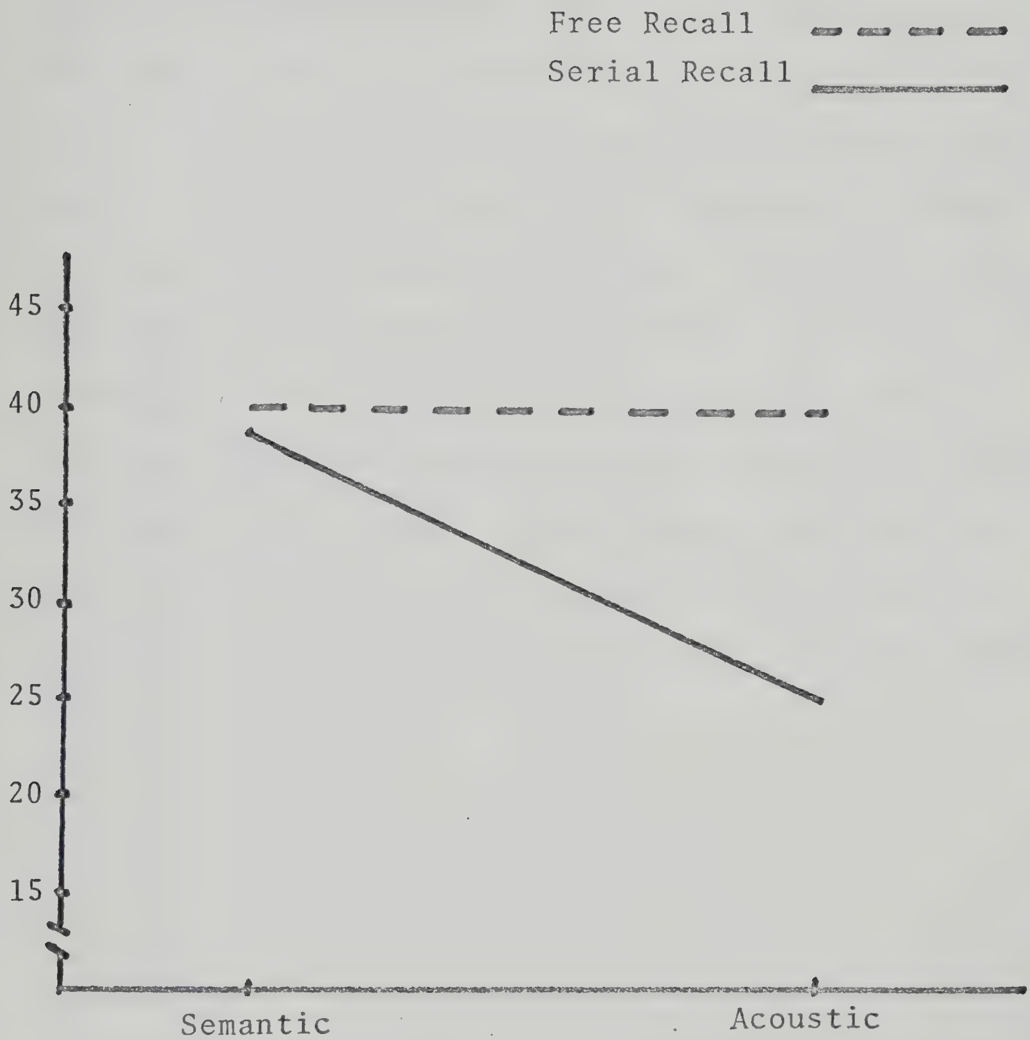

Fig. 27. Number of Control Words Recalled in Acoustic and Semantic Samples

Correlations of Tests

The inter-correlations of the tests were computed and are presented in Table 17. Cross-modal coding correlates the lowest with the auditory short-term memory semantic test. The high correlations among the auditory short-term memory tests give indications of the degree to which the tests are measuring the same thing. Of note is the fact that all the correlations are positive and all are significantly ($p < .01$) different from zero except CMC with auditory short-term memory semantic control words for both free and serial recall. This finding indicates that the three types of tests were measuring similar but not identical processes exclusive of errors of measurement.

TABLE 17

CORRELATION OF TESTS FOR ALL GROUPS

	CMC	STMAUD FR Acoustic		STMAUD FR Semantic		STMAUD SR Acoustic		STMAUD SR Semantic	
		C	E	C	E	C	E	C	E
STM VIS	.59[a]	.37[b]	.37	.51	.62	.44	.45	.56	.59
CMC		.45	.50	.17	.36	.42	.44	.22	.39
STM AUD FR Acoustic Control			.87			.59	.62		
STM AUD FR Acoustic Exp.						.47	.65		
STM AUD FR Semantic Cont.					.84			.86	.71
STM AUD FR Semantic Exp.								.87	.90
STM AUD SR Acoustic Cont.							.72		
STM AUD SR Semantic Cont.									.87

a - N = 120 for this correlation

b - N = 60 for all correlations under STMAUD.

CHAPTER V

DISCUSSION AND CONCLUSIONS

Presented in this chapter is a discussion of the implications that can be drawn from the results as they relate to the experimental hypotheses, the general findings of Jensen, and the existing short-term memory research.

Hypotheses and Results

The first major hypothesis, that there would be no performance differences between the retarded and MA-matched normals was rejected. On all the tasks, the performance of the low average IQ subjects was superior to the performance of retardates even though they were matched for MA. Thus we seem to have here a set of experimental situations which are sensitive to IQ differences when the level of intellectual functioning (MA) is held constant. Thus Zigler's (1967) developmental hypothesis "that there are no differences in formal cognitive functioning between familial retardates and normals matched on general level of cognition (typically measured by MA)(p. 579)" is not confirmed by the findings of this investigation.

The second major hypothesis postulated a significant interaction between IQ and socioeconomic status (SES). This was confirmed in the visual short-term memory task and in the auditory short-term memory semantic task scored for

serial recall. Significance was not reached in the other experimental tasks but in each case, the results were in the hypothesized direction.

Both of the minor hypotheses were substantiated. The performance on acoustic or semantic lists was poorer than performance on the control lists. Acoustic intra-list interference produced poorer performance than semantic intra-list interference. These findings are consistent with the findings of Baddeley (1964, 1966), Baddeley and Dale (1966), and Gumenick (1969).

Group Differences and MA Matching

In the current investigation retarded and normal subjects were MA and SES matched. Therefore, the probability of finding differences between normals and retardates was greatly reduced. Despite the MA match, retarded-normal differences on each of the four tests were found. As Baumeister (1967) suggests, however, the significance of these findings may be restricted to the determination of yet another method of diagnosing intellectual inadequacy. While this may be true for CMC, much more information can be gleaned from the data as is in evidence in the remainder of this chapter.

Differences between the two SES groups within the normal IQ level and within the low IQ level are similarly reduced. The effect found by Jensen failed to reach

significance in most tests. This can be attributed to the method of sample selection. Low SES retardates were MA matched with low SES, normal IQ subjects. High SES retardates were MA matched with high SES, normal Ss. The low SES normals were not MA matched with high SES normals. The high SES normals had MA's about eight months higher than the low SES normals. Similarly within the two groups of retardates, the high SES retardates had MA's about eight months higher than the low SES, culturally deprived retardates. Therefore the general finding that within the two normal groups, the high SES subjects performed better than the low SES subjects is expected. The unexpected finding was that despite a lower MA of eight months, the culturally deprived, low SES retardates performed better than the high SES retardates. If it had been possible to have an MA match across all four groups, then the differences between the culturally deprived retardates and the high SES retardates would probably have reached significance. Perhaps this type of finding led Jensen to postulate a differential distribution of level I and level II abilities by social class.

Another factor may have contributed to the failure to find performance differences between the two samples of retardates. The possible effect of regression, due to less than perfect reliability of measurement may be operative in the manner described here. Low SES, low IQ subjects will

not have as much upward regression as their middle and upper class retarded counterparts because they (the culturally deprived low SES, low IQ) are closer to their SES group mean. Jensen would thus argue that any regression effect would decrease the difference between the two groups of retardates by some amount. Regression effects, then, work against the Jensen hypothesis of the superior performance of the low SES, low IQ group.

The most common criticism of Jensen is that his formulations are basically racist, vouching for, and explaining why whites are better than negroes. However, in this investigation, significant differences were found within one color with social class and IQ differences within a range that was not as broad as that used by Jensen. In the current study all Ss came from schools which were not segregated on the basis of socioeconomic status or race. Children from extremely poor slum conditions did not compose the bulk of the culturally deprived sample. The author knows of only two of the thirty children in the low SES, low IQ group that could be so described. Similarly with IQ, Jensen compares children of 60 - 80 IQ with those of 100 - 120 IQ. In this investigation the maximum IQ was 99. Thus the groups are not as disparate as those used by Jensen. Yet, the differences, although not always significant, were in the predicted direction in each of the tests.

Level I and Level II: Some Comments

Auditory short-term memory was, perhaps, the one test of the three major test types that involved the least amount of cognitive processing. Some support for this statement can be drawn from the correlation of the test scores, especially for semantic control lists. They were the ones recalled most frequently since between-list and within-list interference was minimally operative. Thus it can be argued that this particular list of auditory short-term memory probably was the best measure of Jensen's level I ability. Jensen (1968) has found that digit span was the best measure of level I. Visual short-term memory would be comparable to a digit span task. If a rank of the tests is of any value, the purest measure, as found here, of level I would be semantic auditory short-term memory, then acoustic short-term memory, visual short-term memory, and the least pure measure would be cross-modal coding. The last one perhaps measures more of level II, abstract conceptual ability than do the others. An alternative dimension would be to place the tests on a continuum of amount and complexity of cognitive operation necessary in the encoding and decoding process. Jensen's earlier position was not consistent with this interpretation but in a recent publication Jensen (1970) agrees with this dimension but holds that it is the resultant of at least two types of ability bringing the discussion back to level I

and level II abilities.

The educator will still like to know if adequate level I ability could be used to overcome level II deficiency in children. Research on this question may provide alternative teaching strategies so that differences between normal and culturally deprived individuals can be reduced. If the differences can be reduced to the point where the culturally deprived youngster is indistinguishable from the normal individual in later life, then the distinction made by Jensen (1970) between primary and secondary retardation becomes important for remedial programs.

Basically the distinction is that primary retardation refers to level I deficiency. In this type of retardation, the individual has little intellectual ability to develop. Perhaps specific physical skills could be maximized so as to increase the probability that this individual could be employable. Secondary retardation, on the other hand, refers to a deficiency in level II with the assumption of adequate level I. The latter group should not be labelled as retarded since many of this group would be employable and able to function adequately in society. In the current investigation, the primary retardates would be those individuals who scored low on all three measures of level I ability. These are the high SES, retardates and could possibly be thought of as "true retardates". On the other hand, if an individual is able to "pass" as normal in

later life, labelling him as retarded and treating him educationally like the "true retarded" may do him a great disservice. Therefore continued efforts are necessary to further clarify the nature and etiology of retardation.

Auditory Short-Term Memory: Technical Comment

One of the unexpected findings was that on semantic experimental lists, group 3 (low IQ, high SES) experienced extreme difficulty when compared to their performance on the semantic control lists and compared to the other groups. The significant ($p < .01$) four factor interaction may have several possible explanations.

The significant finding means that the retarded individuals of high SES were susceptible to semantic interference in serial recall. If Baddeley (1966) is correct in his conclusion that acoustic interference occurs in short-term memory, and semantic interference is a variable only for long-term memory, then one of two things is happening. Firstly the subjects could be using part of the long-term storage facility to store the information even though the retention interval is essentially zero. There seems to be no logical basis for this conclusion since this does not seem to be the case with any of the other groups. The possibility does exist, however, that this group of subjects processes this type of information differently than any of the other groups. One cannot

conclude that their overall short-term memory is poor, since the recall scores for the control words was as good as their low SES counterparts on serial recall.

If one looks only at the experimental lists in semantic auditory short-term memory, the superior performance of the low IQ low SES individuals found by Jensen is also supported by the current data. However, no support for this hypothesis is found when the control sequences are examined. Therefore the results are not always consistent with the assumption of level I and level II. From the data, it appears that the information is processed differently by the high SES retardates than by the normals and the culturally deprived retardates. In a recent publication Ellis (1970) reaches the same conclusion via a different methodological approach. He further specifies that the poor performance of retardates can be attributed to defective rehearsal strategies. The current investigation does not suggest such an interpretation. Rather, since order only seemed to be of essence, mechanisms of retrieval rather than storage may be of crucial importance. Further research is necessary to clarify the nature of the retardates' poor performance.

Educational Implications: A Comment

In any psychological assessment procedure in special education that specifies the strength and weaknesses

of the child, the educator and the psychologist usually develop an educational program for the child. The basic question becomes, should the focus of education be on the child's strengths, maximizing the areas in which the child demonstrates capability, or, should education be directed toward developing the deficient abilities of the child? The future research that Jensen (1970) suggests is an attempt to combine the two types of approaches and circumvent the philosophical issue involved. The direction that research should move should be towards determining if abstract-conceptual abilities could be developed in children who show adequate rote-associational abilities. Stated in psycho-educational terms, can the child's cognitive strengths be used to reduce perceived areas of cognitive deficiencies. Future research within this framework may prove to be both interesting and informative.

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APPENDIX 1

STIMULUS WORDS USED IN THE STUDY

APPENDIX 1

STIMULUS WORDS USED IN THE STUDY

Control	Acoustic	Semantic
cow	mad	big
day	man	long
bar	mat	great
few	cap	tall
hot	cat	large
pen	can	high
key	cab	wide
wall	pan	fat
book	tap	huge

APPENDIX 2

APPENDIX 2

Random orders for words

1.	7516
2.	2183
3.	6897
4.	9385
5.	7459
6.	7213
7.	3642
8.	4856
9.	2138
10.	4219
11.	7925
12.	6481

Random orders for presentation of lists

List No.		Order No.
1	Control	1
2	Experimental	1
3	Control	2
4	Experimental	2
5	Control	3
6	Control	4
7	Control	5
8	Experimental	3
9	Experimental	4
10	Control	6
11	Experimental	5
12	Control	7
13	Experimental	6
14	Experimental	7
15	Control	8
16	Control	9
17	Experimental	8
18	Experimental	9
19	Control	10
20	Experimental	10
21	Control	11
22	Experimental	11
23	Experimental	12
24	Control	12

A P P E N D I X 3

WORD LISTS PRESENTED IN EACH EXPERIMENTAL CONDITION

APPENDIX 3

Word lists presented in each experimental condition

	Acoustic	Semantic
1.	key hot cow pen	key hot cow pen
2.	cab cat mad can	wide large big high
3.	day cow wall bar	day cow wall bar
4.	man mad pan mat	long big fat great
5.	pen wall book key	pen wall book key
6.	book bar wall hot	book bar wall hot
7.	key few hot book	key few hot book
8.	can pan tap cab	high fat huge wide
9.	tap mat pan cat	huge great fat large
10.	key day cow bar	key day cow bar
11.	cab cap cat tap	wide tall large huge
12.	bar pen few day	bar pen few day
	45 second rest	45 second rest
13.	cab man mad map	wide long big great
14.	mat can cap man	great high tall long
15.	few pen hot wall	few pen hot wall
16.	day cow bar wall	day cow bar wall
17.	cap pan cat can	tall fat large high
18.	man mad mat pan	long big great fat
19.	few day cow book	few day cow book
20.	cap man mad tap	tall long big huge
21.	key book day hot	key book day hot
22.	cab tap man cat	wide huge long large
23.	can cap pan mad	high tall fat big
24.	pen few wall cow	pen few wall cow

APPENDIX 4

INSTRUCTIONS

APPENDIX 4

INSTRUCTIONS

I am going to say some words. When I am finished I want you to say the words just the way I said them. There will be four words in each group. I'll repeat the instructions. I am going to say some groups of words. When I am finished, I want you to say the words just the way I said them. Let's try a group of words. Ready? Big long great tall (Pause) You should have said, big long great tall. Each time I say a group of four words, I want you to say the words in exactly the same order that I do. Let's try another group of words. Ready? Cow day key few (Pause) You should have said, cow day key few. Let's try one more list of words. Ready? Man mad map pan (Pause) You should have said man mad map pan. You see, when I say a group of words, I want you to say the same words just as I do. Now let's try some other groups of words. Ready (begin test).

A P P E N D I X 5

INSTRUCTIONS FOR VISUAL SHORT-TERM MEMORY

APPENDIX 5

INSTRUCTIONS FOR VISUAL SHORT-TERM MEMORY

I am going to show you some numbers and some colors. I want you to watch the screen and do as I tell you (project slide 1). Look at these numbers, try to remember each number (pause then project slide 2), now name these colors starting at the top (pause then project blank slide 3). Now write the numbers you saw at first on this paper. Good [If incorrect repeat example 1].

Now let's try another one (project slide 4). Look at these numbers and try to remember them (Pause briefly then project slide 5) name these colors starting at the top (project blank slide 6). Now write the numbers you have just seen.

[Repeat until subject understands the instructions and can successfully reproduce the digits.]

<u>set timers</u>

Now we are going to try again but we will go a bit faster. Ready? (Engage timers [As the first sequence progress say] look at the numbers . . . name the colors . . . Write . . .

Let's try another set. Ready? (engage timers) Good. Remember to look at the numbers, name as many colors as you can, then write the numbers.

[Start test with each trial preceded by a ready signal]

A P P E N D I X 6

STIMULI NUMBERS FOR VISUAL SHORT-TERM MEMORY

APPENDIX 6

STIMULI NUMBERS FOR VISUAL SHORT-TERM MEMORY

1. 9 8 4 5 1
2. 9 6 3 1 5
3. 2 4 9 7 1
4. 7 2 3 9 6
5. 7 5 2 9 4
6. 4 8 9 3 1
7. 5 4 8 1 6
8. 9 7 5 3 1
9. 3 5 6 1 8
10. 7 3 9 8 4
11. 3 8 6 9 4
12. 5 3 6 1 9
13. 6 3 2 9 5
14. 2 3 5 9 6
15. 8 1 6 5 3
16. 1 3 5 8 9
17. 2 4 5 8 1
18. 8 3 6 5 1
19. 1 5 6 3 8
20. 5 9 2 3 6

A P P E N D I X 7

INSTRUCTIONS FOR CROSS MODAL CODING

APPENDIX 7

INSTRUCTIONS FOR CROSS MODAL CODING

I am going to let you listen to some patterns of sounds. Listen carefully. (Examples 1, 2, and 3 without the visual stimulus cards were presented.) Each of the patterns you heard are just like the dots you see on this card. (Card shown) Lets take a look at each one. Here is what the first one sounded like. (Example 1 presented.) This is what the second one sounded like. (Card 2 shown and Example 2 presented.) You see. It is just like the dots that are on this card. Lets take a look at the other one that we listened to. (Card 3 shown and Example 3 presented.) Each pattern you hear is going to be like one of the dot patterns you see here. Let me show you. Listen! (Card 4 shown, Example 1 presented. N.B. Card 4 and all subsequent cards contain 3 possible sound patterns of which one is correct. Cards 1-3 contain only the correct pattern.) Which one did you hear? It was this one. (Examiner points to the correct pattern.) Listen again then you show me which one you heard. Ready? (Card 5 shown and example 2 presented.) Which one is it? (Subject points.) Lets listen to a different one. Ready? (Card 6 shown, example 3 presented.) Which one is it this time? Lets try another one. You show me which one you heard. Ready? (Example 1 presented, followed immediately by Card 7.) Listen again and then show me which one you have heard. (Example 2 presented, then card 8 shown.) Ready? (Example 3, then card 9). Ready? (Example 1, then card 10). Ready? (Example 2, then card 11). Ready? (Example 3, then card 12). If the subject did not correctly identify any of the last three stimuli the instructions were repeated until he could.) Listen carefully and pick out the dots that look like the tones you hear. Ready? (Test item one presented followed by the rest of the test.)